telephony

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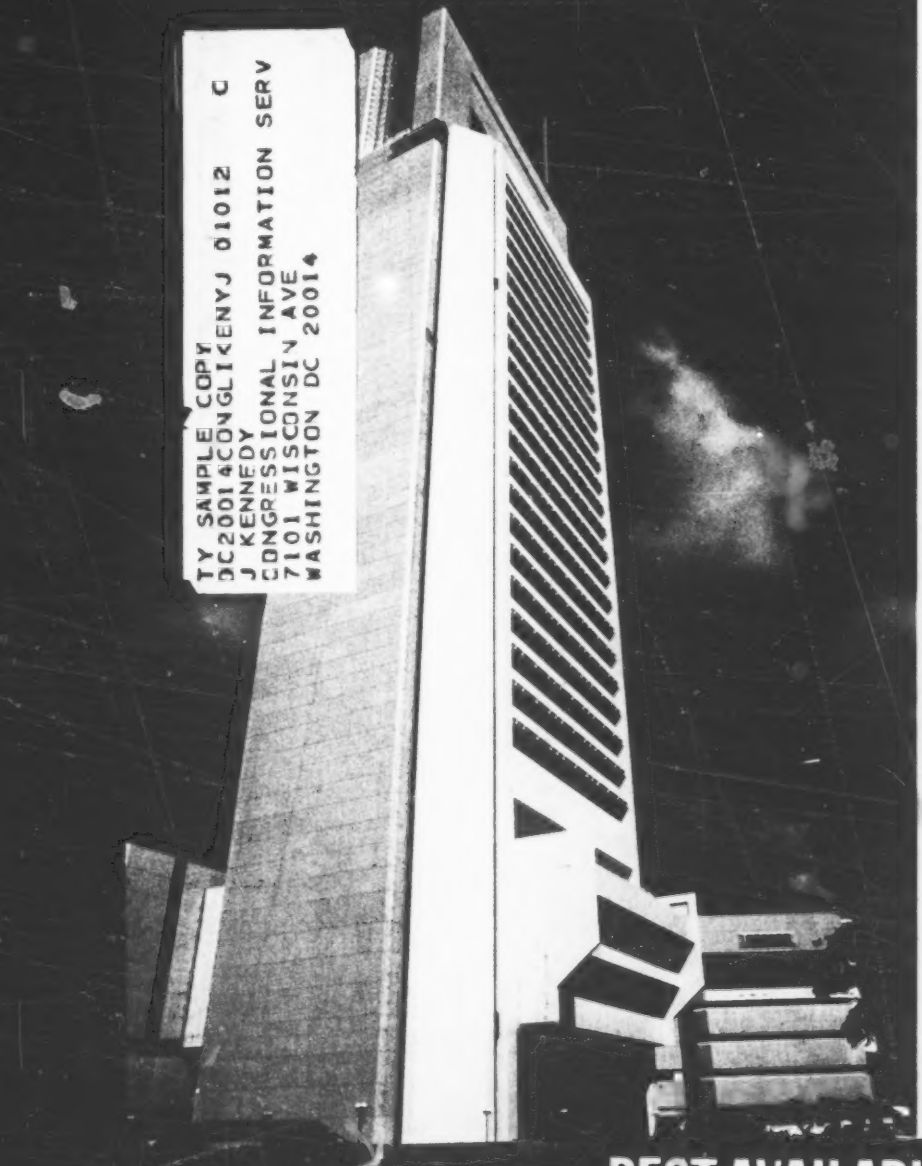

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DAN S. FARGO, PUBLISHER

World telecom spending to rise 13.3% in 1980 over 1979 spending levels as world turns to technology to solve social, economic problems

Int'l telecom spending levels to increase in '80

WORLD-OUTSIDE-the-United-States telecommunications construction spending is forecasted to jump 13.3% in 1980.

Is this advance due to Telecom 79 and the many other shows last year with their almost magical equipment displays and inspiring programs?; or was it the technical cooperation program of the International Telecommunication Union that sends experts and advisers to enhance communication development all over the world?; was it the pervasive influence for telecom progress found in the industry's trade magazines?; or could it have been the requests and demands of business and residence customers of the world's PTTs? Surely all of these plus more fed the imagination of PTT managers and technical personnel as they planned this ambitious 13.3% move forward for 1980—despite gloomy expectations of a downturn in world business in the midst of continuing crippling inflation.

The gross spending amount for 1980 is $40.456 billion, up from $35.704 billion in 1979, and $33.138 billion in 1978 (see Table A).

With construction expenditures in the United States estimated at $20.921 billion for 1980, this gives a world total of $61.377 billion. That is a rise of 10.5% from 1979's $55.549 billion level. The U.S. contributes only a 5.4% increase to the 1980 amount.

But let's step back for a moment and more carefully analyze that "only a 5.4% increase." A look at earlier U.S. telecom spending shows that there were leaps upward of 19.5% in 1969; 21.7% in 1970; 16.5% in '77; 19.4% in '78, and 13.9% for '79; so we can say U.S. telecom spending leveled off on a rather high plateau.

Similarly, world-other-than-U.S. budgets took a big leap in 1977—26.3%. (Regrettably, our TELEPHONY surveys of worldwide spending only go back to 1975.)

Survey results appear in Tables 1 and 2, pp. 86-103.

Our 1980 estimate is based on extrapolated* survey returns from 82 telecom administrations representing approximately 62.7% of the world-outside-the-U.S.'s estimated 297,000,000 telephones as of Dec. 31, 1979.

A 1981 construction spending estimate—$40.373 billion—can be obtained by extrapolating the '81 returns, but 35.6% really is too narrow a base for a dependable result. And, after all, what are most important are the individual countries' forecasts. Where these are available for 1981, they are useful for indicating the trend ahead.

A word now about the pivotal 297 million non-U.S. phone total mentioned above. We have assumed 6% growth from Dec. 31, 1977's 261,010,000** to obtain 279,440,000 for Dec. 31, 1978; then 6.28% growth in '79 to reach the 297 million mark. (Formerly we'd taken the average of growth rates of the available preceding five years and assumed this was the growth rate for the year just ended. Since this produced a consistently high result, we've scaled the growth rate down for this writing.) Adding in the estimated Dec. 31, 1979 Bell System's 141,638,000 phones and those of the U.S. Independents, 33.4 million, gives a world total of

Continued on page 102

*We used our usual "straight extrapolation," which assumes construction expenditures in non-reporting nations were in the same proportion to telephones in place at the end of 1979 as those in reporting nations. Spending amounts for 1978 were received from countries representing 61.4% of non-U.S. phones for 1979, 62.9%, and 1981, 35.6%. Our annual word of caution: this latter percentage is a narrow base for extrapolation.

**As reported in "The World's Telephones," published by AT&T Long Lines, Overseas Administration, Bedminster, N.J., issued dated December 1978.

Table A

Annual telecommunication construction spending ($ billions)

	World outside U.S.	Increase	United States	Increase	World Total	Increase
1975	23.837	—	11.947	—	35.784	—
1976	25.450	6.8	12.525	4.8	37.975	6.1
1977	32.140	26.3	14.590	16.5	46.730	23.1
1978	33.138	3.1	17.422	19.4	50.560	8.2
1979	35.704	7.7	19.845	13.9	55.549	9.9
1980	40.456	13.3	20.921	5.4	61.377	10.5

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Table 1 World Telephone Totals

North America	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
Canada			
Community Tel. Co. of Ontario Ltd., Dunnville	n/a†	n/a	n/a
Edmonton (Alta.) Tels.	497,255	175,709	n/a
Northern Tel. Ltd., New Liskeard, Ont.	121,916	41,099	n/a
Ontario members Can. Ind. Tel. Assoc. excluding Northern Tel. and Ontario Northland Telecom.	310,000	n/a	n/a
Quebec-Telephone, Rimouski	552,000	150,000	27,000
City of Thunder Bay (Ont.) Tel. System	124,500	43,753	2,350
Telebec Ltd., Montreal	n/a	n/a	n/a
Transcanada Telephone System: Alberta Government Tels.	1,525,000	435,000	n/a
Bell Canada	13,371,356	4,458,563	n/a
British Columbia Tel. Co.	2,568,000	902,000	147,000
The Island Tel. Co. (Prince Edward Island)	122,800	35,200	n/a
Manitoba Tel. System	1,032,400	328,004	25,886
Maritime T.&T. Co. Ltd. (Nova Scotia)	854,700	247,000	n/a
New Brunswick Tel. Co.	698,700	205,000	18,292
Newfoundland Tel. Co. Ltd.	416,739	104,919	n/a
Saskatchewan Telecommunications	971,510	291,150	n/a
Mexico, Telefonos de	23,010,776	11,964,000	450,000
Middle America			
Bahamas			
Bahamas Telecom. Corp.	231,200	46,240	n/a
Grand Bahama Tel. Co., Ltd.	21,000	6,560	1,250
Barbados	250,000	65,000	n/a
Bermuda	57,810	18,000	4,200
Costa Rica	2,206,922	441,384	n/a
Dominican Republic	5,300,000	n/a	n/a
Puerto Rico Communications Authority	447,000	115,812	7,392
Virgin Islands (U.S.)	101,000	30,122	11,800
South America			
Bolivia			
Bolivian Assoc. of Tel. Cos.	4,956,540	n/a	n/a
Brazil			
Cetel, Rio de Janeiro	2,066,974	470,398	39,571
Telamazon, Manaus	1,342,000	152,493	n/a
Telebahia, Salvador	9,287,000	n/a	n/a
Telemig, Belo Horizonte	8,925,412	1,052,426	125,938
Telepar, Curitiba	9,890,000	827,000	146,000
Telpa, Joao Pessoa	2,902,700	604,729	8,138
Chile	11,010,483	2,105,000	200,000
Colombia			
Emcali, Cali	1,164,764	158,100	17,860
Empresas Publicas de Medellin	2,013,000	324,700	n/a
Ministry of Communications & Telecom	26,586,970	4,506,266	n/a
Peru			
Cia. Peruana, Lima	4,804,866	960,973	n/a

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
2,731	8,436	20,025	6,939	33,131
79,986	80,066	193,527	79,608	433,187
7,289	24,838	37,990	13,518	71,455
n/a	n/a	n/a	n/a	204,082
32,000	30,000	169,000	41,000	268,000
10,823	23,775	42,418	14,445	91,461
16,955	28,600	92,100	18,000	155,655
125,700	219,700	517,350	251,250	1,114,000
1,294,943	1,675,586	4,684,226	1,818,170	9,270,398
168,183	115,522	929,466	317,061	1,777,164
4,350	12,052	36,098	11,612	64,112
69,079	54,289	348,068	126,763	674,883
61,579	64,668	259,698	88,534	474,479
33,605	35,089	201,620	70,407	376,125
23,337	30,957	99,537	39,002	192,833
56,706	41,585	314,124	113,748	594,300
386,756	114,205	982,900	628,810	4,341,656
6,220	22,515	15,781	8,536	53,052
1,712	5,830	3,908	2,381	13,831
6,700	14,300	29,300	3,650	54,100
2,990	16,150	16,665	7,490	43,295
31,720	47,580	90,280	135,420	189,000
22,900	35,000	75,000	15,700	150,000
8,510	11,613	34,965	6,959	62,047
5,100	9,350	17,625	3,875	37,500
n/a	n/a	n/a	n/a	106,100
22,062	5,744	10,667	3,500[7]	41,973[7]
8,435	1,914	18,384	3,900	40,420
n/a	n/a	n/a	n/a	157,660
92,758	126,958	277,611	42,831	542,600
61,700	111,600	133,600	61,500	371,000
8,944	7,635	25,472	1,783	44,053
115,717	161,878	239,033	47,476	564,104[1]
25,235	4,900	47,242	2,100	79,497
34,187	10,256	164,325	49,297	216,500
n/a	n/a	n/a	n/a	1,056,155
37,720	66,270	159,072	34,251	365,170

Continued on page 90

Table 1 World Telephone Totals (continued)

	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
Europe			
Austria	7,500,000	2,700,000	n/a
Denmark			
Fyns Kommunale Telefonselskab, Odense	n/a	190,000	11,000
Telefontilsynet, Copenhagen	5,120,000	2,185,000	n/a
Jydsk Telefon, Arhus	2,090,000	730,000	150,000
Finland	4,719,000[2]	1,603,000	n/a
Germany, Federal Republic of	61,323,000	23,600,000	1,903,000
Greece	9,487,500	3,215,000	n/a
Hungary	10,699,000	n/a	n/a
Iceland	226,000	n/a	n/a
Ireland	3,400,000	850,000	n/a
Malta	314,000	n/a	n/a
Netherlands	14,070,000	4,930,000	500,000
Norway	4,080,743	1,590,000	n/a
Portugal	9,899,300	2,345,225	n/a
Spain	37,150,000	9,750,000	n/a
Sweden	8,300,000	3,400,000	210,000
Switzerland	6,355,000	2,695,000	n/a
United Kingdom[8]	55,769,000	19,846,000	2,200,000
Asia			
Bahrain	365,000	n/a	n/a
Brunei	209,000	n/a	n/a
China/Taiwan	17,535,000	3,577,000	479,000
Cyprus	623,000	157,000	29,000
Hong Kong	4,970,000	1,030,000	220,000
Israel	3,820,000	1,027,000	n/a
Japan	116,890,000[6]	35,891,000	n/a
Kuwait	1,320,000	199,000	28,500
Nepal	12,000,000	2,100,000	n/a
Philippines			
Philippine Long Distance Tel. Co	8,349,906	1,391,651	144,726
Republic Tel. Co., Inc.	n/a	n/a	n/a
Qatar	200,000	34,000	n/a
Telecom Singapore	2,377,383	495,000	68,000
Thailand	46,243,600	7,609,000	460,000
Africa			
Ethiopia	30,000,000	n/a	n/a
South Africa, Republic of	n/a	n/a	n/a
Zimbabwe Rhodesia	7,140,000	940,000	3,500
Oceania			
Australia	14,331,600[8]	4,722,008[9]	n/a
Fiji	613,000[8]	97,233[11]	n/a
Guam	125,000	18,000	9,000
Mariana Islands	113,270	14,000	200
New Zealand	3,144,600	1,066,500	109,759[12]
Pitcairn Island	65	16	0

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
2,034,854	770,000	n/a	n/a	2,804,854
30,000	40,000	143,000	22,000	235,000
n/a	n/a	n/a	n/a	3,080,000
210,000	248,000	602,000	90,000	1,150,000
380,000	578,000	1,270,000	n/a	2,240,000
2,100,000	n/a	19,228,000	7,500,000	26,700,000[2]
620,700	n/a	1,519,770	n/a	2,667,610
203,303	556,545	345,551	65,262	1,180,679
15,000	n/a	64,600	n/a	103,000
186,000	n/a	246,000	n/a	580,000
50,025[3]	n/a	27,305[4]	n/a	77,330
n/a	n/a	n/a	n/a	5,860,000
n/a	432,600	n/a	n/a	1,730,000
n/a	n/a	n/a	n/a	1,300,000
2,263,683	n/a[5]	4,259,901	n/a	11,128,000
725,000	1,980,000	3,972,000	445,000	6,397,000
n/a	n/a	n/a	n/a	4,440,000
3,600,000	6,900,000	14,200,000	2,300,000	27,000,000
10,433	n/a	22,814	n/a	60,424
n/a	n/a	n/a	n/a	15,000
573,000	172,000	1,147,000	190,000	2,595,000
n/a	n/a	n/a	n/a	100,000
280,250	260,150	890,750	86,850	1,518,000
n/a[17]	n/a	n/a	n/a	1,080,000
n/a	n/a	n/a	n/a	53,282,000
53,650	46,400	91,350	11,600	193,000
n/a	2,600	n/a	n/a	12,500
110,495	93,856	193,598	41,088	519,642
8,244	3,100	21,382	1,910	46,822
7,000	n/a	14,000	n/a	31,000[7]
122,014	144,114	342,758	16,244	625,130
140,260	49,090	157,350	55,073	463,000
n/a	n/a	n/a	n/a	90,730
423,000	938,000	1,152,000	55,000	2,605,000
94,849[14]	115,252[15]	n/a	n/a	210,101
1,282,970[10]	n/a	3,166,498[10]	n/a	6,676,576[10]
n/a	n/a	n/a	n/a	37,326
4,000	7,000	11,000	2,000	24,000
885	295	376	60	1,836
176,049	n/a[13]	906,489	n/a[13]	1,762,310
n/a	n/a	n/a	n/a	28

Continued on page 92

Table 1 World Telephone Totals (continued)

	Estimated population 12/31/79 of serving area	Households 12/31/79 (est.)	Businesses 12/31/79 (est.)
Solomon Islands	215,000	n/a	n/a
Tonga	103,000	17,000	146

Footnotes, Table 1

†not available
[1]Est. total tels. for Chile, Est. total tels. for Chile telco 546,974; other telcos: 17,130
[2]Data in Table are for both Finnish PTT and the independent telcos
[3]Includes business extensions
[4]Includes residence extensions
[5]Business extension phones plus residence extensions total 4,451,200
[6]As of March 31, 1980, as is rest of data

Table 2 World Plant Investment, Service Revenues and Construction Expenditures

excluding land and buildings ($ millions)

North America	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction: Inside plant	Actual 1978 construction: Outside plant
Canada				
Community Tel. Co. of Ontario	21.600	5.206	.684	1.270
Edmonton Tels.	329.678	87.509	14.345	10.245
Northern Tel. Ltd.	41.401	13.983	.598	1.609
Quebec-Telephone	327.000	96.000	n/a†	n/a
Thunder Bay Tel. System	42.000	n/a	.222	1.208
Telebec Ltd.	120.407	40.900	5.934	4.905
Transcanada Tel. System: Alberta Govt. Tels.	1,349.612	445.400	100.172	41.670
Bell Canada	7,361.340	2,404.565	235.800	273.000
Island Tel. Co.	49.677	16.171	2.181	2.355
Manitoba Tel. System	555.372	162.576	37.081	19.723
Maritime Tel. & Tel. Co.	414.986	141.392	1.666	12.594
New Brunswick Tel. Co.	356.263	117.173	12.942	10.455
Newfoundland Tel. Co. Ltd.	n/a	n/a	8.999	5.360
Saskatchewan Telecoms	538.645	168.470	28.408	33.185

Business telephone main stations 12/31/79 (est.)	Business extension telephone stations 12/31/79 (est.)	Residence telephone main stations 12/31/79 (est.)	Residence extension telephone stations 12/31/79 (est.)	Total telephones 12/31/79 (est.)
660	630	340	140	1,770
117	71	1,017	49	1,134

[7]TELEPHONY estimate
[8]12/31/78
[9]6/30/78
[10]6/30/79
[11]12/31/76
[12]Registered companies
[13]Business extension phones plus residence extensions total 669,982
[14]Business main stations plus residence mains
[15]Business extension phones plus residence extensions
[16]6/30/80
[17]Of Israeli main stations, 24% are business; 76% residence
[18]Telephone totals are as of 10/31/79

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside plant		Outside plant		Station apparatus		Other		Total
.185	.058	2.198	79) 80) 81)	.680 .410 .455	79) 80) 81)	.978 1.350 .970	79) 80) 81)	.136 .220 .220	79) 80) 81)	.043 .042 .013	79) 80) 81)	1.836 2.022 1.658
19.611	1.613	45.814									79) 80) 81)	47.618 53.515 56.125
.437	1.588	4.232									79) 80) 81)	5.712 5.336 5.515
n/a	n/a	44.000									79) 80) 81)	40.200 44.408 51.000
1.877	.263	3.569	79) 80) 81)	.593 4.137 .997	79) 80) 81)	1.505 1.517 1.254	79) 80) 81)	1.711 2.701 3.506	79) 80) 81)	1.092 .478 .391	79) 80) 81)	4.901 8.833 6.148
3.566	1.031	15.436	79) 80) 81)	6.244 7.026 n/a	79) 80) 81)	5.563 7.717 n/a	79) 80) 81)	4.061 4.323 n/a	79) 80) 81)	1.306 2.320 n/a	79) 80) 81)	17.174 21.386 n/a
52.884	24.051	218.777	79) 80) 81)	90.108 97.436 101.772	79) 80) 81)	46.544 51.548 54.321	79) 80) 81)	80.706 98.683 112.260	79) 80) 81)	55.729 49.441 39.779	79) 80) 81)	273.086 297.107 308.132
225.800	106.400	841.000	79) 80) 81)	273.600 306.500 339.700	79) 80) 81)	283.700 296.600 290.300	79) 80) 81)	280.900 283.300 262.800	79) 80) 81)	120.100 189.800 166.000	79) 80) 81)	958.300 1.076.000 1.058.800
1.343	.382	6.260	79) 80) 81)	1.794 2.954 2.686	79) 80) 81)	2.499 1.794 2.159	79) 80) 81)	1.556 1.891 2.142	79) 80) 81)	1.700 1.352 1.003	79) 80) 81)	7.548 7.990 7.990
14.990	7.100	78.894	79) 80) 81)	18.986 21.728 21.519	79) 80) 81)	20.122 20.987 23.549	79) 80) 81)	15.853 19.749 20.441	79) 80) 81)	3.340 4.054 6.003	79) 80) 81)	58.301 66.518 71.511
9.050	3.180	26.490	79) 80) 81)	11.509 15.181 27.102	79) 80) 81)	16.618 17.153 14.875	79) 80) 81)	10.833 11.471 12.278	79) 80) 81)	5.750 9.915 4.820	79) 80) 81)	44.710 53.720 59.075
6.731	3.132	33.260	79) 80) 81)	9.257 13.763 13.873	79) 80) 81)	9.599 9.972 10.061	79) 80) 81)	8.482 9.189 9.272	79) 80) 81)	17.192 4.900 4.944	79) 80) 81)	44.530 37.824 38.150
4.874	3.674	22.907	79) 80) 81)	8.952 7.946 8.210	79) 80) 81)	4.856 5.310 5.525	79) 80) 81)	5.551 5.183 6.416	79) 80) 81)	6.990 11.141 7.049	79) 80) 81)	26.349 29.580 27.200
17.011	2.682	81.286	79) 80) 81)	24.905 33.235 36.125	79) 80) 81)	36.125 44.625 51.595	79) 80) 81)	15.555 15.555 17.595	79) 80) 81)	4.165 4.760 2.975	79) 80) 81)	80.750 98.175 108.290

Continued on page 94

Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction: Inside plant	Actual 1978 construction: Outside plant
Telesat Canada	170.760	n/a		
Mexico, Telefonos de	409.270	752.440	n/a	n/a
Middle America				
Bahamas				
Bahamas Telecom Corp.	2.380	26.360	.004	.051
Grand Bahama Tel. Co. Ltd.	10.100	2.886	0	.037
Barbados Tel. Co. Ltd.	41.000	10.626	.419	1.252
Bermuda Tel. Co. Ltd.	28.875	13.406	.721	.510
Costa Rica	168.600	38.651	10.120	5.283
Dominican Republic	102.000	41.700	2.000	2.100
Puerto Rico Communications Authority	61.969	14.990	3.663	1.204
Virgin Islands (U.S.)	61.031	22.288	1.305	.347
South America				
Bolivian Assoc. of Tel. Cos.	124.142	n/a	n/a	
Brazil				
Cetel	12.745	30.780	22.112	12.800
Telamazon, Manaus	n/a	9.764	2.665	1.386
Telebahia	211.595	59.530	20.101	10.813
Telemig	320.000	154.111	56.116	6.946
Telepar	389.514	121.651	41.739	27.826
Telpa, Joao Pessoa	44.328	8.696	1.331	1.731
Chile	1.048.900[1]	110.900[1]	12.100[2]	12.400
Colombia				
Emcali	765.700	264.000	53.000	62.000

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside Plant		Outside Plant		Station apparatus		Other		Total
	47.984	47.984							79)	52.870	79)	52.870
									80)	62.985	80)	62.985
									81)	46.665	81)	46.665
n/a	n/a	2,405.800[17]									79)	323.700
											80)	383.400
											81)	504.800
.015	.013	.084	79)	4.917	79)	1.620	79)	1.216	79)	2.158	79)	9.910
			80)	2.811	80)	.761	80)	1.091	80)	.620	80)	5.283
			81)	n/a	81)	n/a	81)	n/a	81)	n/a	81)	n/a
.022	.129	.188	79)	.011	79)	.066	79)	.270	79)	.138	79)	.484
			80)	1.352	80)	.142	80)	.621	80)	.183	80)	2.297
			81)	n/a	81)	n/a	81)	n/a	81)	n/a	81)	n/a
1.271	.125	3.067	79)	2.670	79)	.855	79)	1.271	79)	.291	79)	5.087
			80)	4.275	80)	.584	80)	1.267	80)	.390	80)	6.516
			81)	3.000	81)	1.000	81)	1.460	81)	.240	81)	5.700
1.266	.380	2.877	79)	1.480	79)	1.025	79)	1.660	79)	.275	79)	4.440
			80)	2.495	80)	.650	80)	.955	80)	1.575	80)	5.675
			81)	.775	81)	.800	81)	.985	81)	1.140	81)	3.700
.676	5.897	21.975	79)	7.000	79)	16.100	79)	3.000	79)	4.500	79)	30.600
			80)	11.974	80)	13.073	80)	4.615	80)	4.602	80)	34.264
			81)	28.974	81)	8.757	81)	7.228	81)	8.390	81)	53.349
4.000	1.000	6.100	79)	3.800	79)	3.000	79)	2.200	79)	1.900	79)	10.900
			80)	8.600	80)	2.800	80)	2.900	80)	2.200	80)	16.500
			81)	7.900	81)	5.300	81)	3.200	81)	2.500	81)	18.900
.376	1.551	6.794	79)	5.124	79)	8.641	79)	1.306	79)	1.868	79)	16.939
			80)	15.594	80)	14.005	80)	3.400	80)	3.947	80)	36.946
			81)	1.122	81)	3.781	81)	3.876	81)	.820	81)	9.599
2.054	.290	3.996	79)	.944	79)	.723	79)	2.090	79)	.344	79)	4.101
			80)	1.247	80)	1.295	80)	1.981	80)	.558	80)	5.081
			81)	2.016	81)	1.054	81)	1.594	81)	.456	81)	5.120
		n/a									79)	n/a
											80)	n/a
											81)	n/a
1.411	2.818	39.141	79)	5.375	79)	5.986	79)	.809	79)	.826	79)	12.996
			80)	6.334	80)	10.656	80)	.305	80)	4.233	80)	21.527
											81)	n/a
.218	.524	4.792	79)	4.973	79)	.265	79)	.548	79)	.678	79)	6.464
			80)	5.668	80)	.634	80)	.271	80)	.190	80)	6.763
.954	6.220	38.088	79)	11.616	79)	16.825	79)	2.033	79)	5.817	79)	36.290
			80)	27.865	80)	19.644	80)	6.565	80)	11.609	80)	65.683
			81)	8.275	81)	15.463	81)	6.937	81)	2.930	81)	33.605
1.504	14.544	79.110	79)	26.329	79)	13.671	79)	2.860	79)	11.084	79)	53.944
			80)	28.348	80)	20.248	80)	4.278	80)	18.666	80)	71.540
			81)	4.804	81)	8.992	81)	1.236	81)	13.178	81)	28.210
4.638	18.551	92.754	79)	29.705	79)	22.220	79)	2.778	79)	22.956	79)	77.659
			80)	52.608	80)	28.345	80)	5.939	80)	20.491	80)	107.383
			81)	49.472	81)	32.939	81)	7.204	81)	14.709	81)	104.324
0	.266	3.328	79)	4.817	79)	1.541	79)	0	79)	.667	79)	7.025
			80)	2.773	80)	4.921	80)	0	80)	.535	80)	8.229
			81)	4.529	81)	4.197	81)	0	81)	1.086	81)	9.875
9.800	2.800	37.100[2]	79)	21.900	79)	17.000	79)	8.700	79)	5.700	79)	53.300[1]
			80)	24.500	80)	31.800	80)	8.600	80)	18.300	80)	83.200[1]
			81)	27.500	81)	28.700	81)	12.700	81)	12.600	81)	81.500[1]
n/a	n/a	126.100	79)	22.000	79)	58.000	79)	n/a	79)	28.000	79)	108.000
			80)	7.000	80)	114.000	80)	n/a	80)	n/a	80)	121.000
			81)	9.000	81)	117.000	81)	n/a	81)	n/a	81)	126.000

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Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction: Inside plant	Actual 1978 construction: Outside plant
Empresas P. de Medellin	21.000	14.000	0	1.200
Ministry of Communications-Telecom	n/a	126.136	n/a	n/a
Peru (Peruana)	189.862	34.683	3.036	2.659
Europe				
Austria	2.434.828	1.021.719		
Denmark				
FKT. Odense	170.000	40.000	10.000	9.500
Jydsk Telefon, Arhus	540.000	194.000	27.400	37.200
Telefontilsynet, Copenhagen	1,750.000[3]	685.000	106.000	98.000
Finland				
National Assoc. of Private Telephone Cos.	333.000	241.000	44.000	35.500
Posts & Telecommunications Administration	642.000[4]	383.000		
Germany, Federal Republic of	4,408.000	13,224.000	n/a	n/a
Greece	1,429.767	463.211	51.882	24.027
Iceland	119.000	n/a	2.658	.858
Ireland	784.000	214.000	47.210	37.403
Malta	43.149	10.100	.551	1.378
Norway	449.800	649.700	190.635	117.668
Portugal	597.177	287.957	14.574	27.167
Spain	10,943.774	1,925.545	516.000	435.976
Sweden	4,001.300	1,545.500	26.800	64.600
Switzerland	8,429.000	1,729.000	205.000	188.000
United Kingdom	17,070.200[8]	6,674.100[8]	716.400[8]	437.800

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside Plant		Outside Plant		Station apparatus		Other		Total
1.200	.320	2.720	79) 80) 81)	3.000 21.600 16.600	79) 80) 81)	1.300 7.500 14.400	79) 80) 81)	n/a 260 2.200	79) 80) 81)	4.000 2.100 4.300	79) 80) 81)	8.300 31.460 37.500
n/a	n/a	20.701									79) 80) 81)	59.314 112.955 156.463
1.331	.063	7.089	79) 80) 81)	10.740 10.988 1.413	79) 80) 81)	3.777 7.844 534	79) 80) 81)	3.943 8.302 0	79) 80) 81)	1.413 4.911 008	79) 80) 81)	19.873 32.045 1.956
		394.651									79) 80) 81)	445.539 500.469 518.344
4.700	6.100	30.300	79) 80) 81)	7.200 6.600 7.900	79) 80) 81)	8.700 11.000 9.800	79) 80) 81)	6.200 6.200 5.900	79) 80) 81)	4.200 5.400 3.900	79) 80) 81)	26.300 29.200 27.500
22.600	12.100	99.300	79) 80) 81)	33.000 45.000 38.400	79) 80) 81)	38.000 41.500 42.000	79) 80) 81)	23.300 28.800 29.200	79) 80) 81)	15.700 21.000 18.000	79) 80) 81)	110.000 136.300 127.600
64.000	14.000	282.000	79) 80) 81)	103.000 83.000 86.000	79) 80) 81)	80.000 100.000 82.000	79) 80) 81)	83.000 84.000 99.000	79) 80) 81)	59.000 62.000 54.000	79) 80) 81)	325.000 329.000 321.000
9.400	23.100	112.000	79) 80) 81)	48.300 53.100 58.200	79) 80) 81)	39.000 42.800 46.900	79) 80) 81)	10.300 11.300 12.400	79) 80) 81)	25.400 27.800 30.500	79) 80) 81)	123.000 135.000 148.000
		179.000									79) 80) 81)	186.000 188.000 183.000
153.120	n/a	2.813.000	79) 80)	n/a n/a	79) 80)	n/a n/a	79) 80)	185.600 229.100	79) 80)	n/a n/a	79) 80) 81)	3.480.000 4.060.000 n/a
18.216	16.681	110.806									79) 80) 81)	204.600 312.803 385.594
.494	2.190	6.199	79)	4.900	79)	750	79)	.015	79)	900	79) 80) 81)	6.565 n/a[5] n/a[5]
26.024	14.805	125.443									79) 80) 81)	161.000 210.000 269.000
.827	—	2.757	79) 80) 81)	4.180 4.574 7.220	79) 80) 81)	1.120 2.589 2.445	79) 80) 81)	406 921 978	79) 80) 81)	— — —	79) 80) 81)	5.705 8.083 10.643
48.568	74.357	431.228	79) 80) 81)	207.323 193.190 169.120	79) 80) 81)	125.945 130.235 129.922	79) 80) 81)	49.535 54.207 59.687	79) 80) 81)	90.032 83.366 76.947	79) 80) 81)	472.835 460.998 435.675
16.311	19.902	77.954	79)	33.544	79)	52.840	79)	24.367	79)	72.101	79) 80) 81)	182.852 229.288 239.433
255.344	83.992	1.292.200	79) 80) 81)	496.206 660.660 792.792	79) 80) 81)	415.390 545.045 654.053	79) 80) 81)	256.911 346.847 416.216	79) 80) 81)	72.401 99.099 118.919	79) 80) 81)	1.240.908 1.651.651 1.981.980
73.800	109.100	274.300[6]									79) 80) 81)	364.000 481.000 594.000
15' 000	—	544.000	79) 80) 81)	213.000 208.000 216.000	79) 80) 81)	176.000 184.000 191.000	79) 80) 81)	166.000 162.000 161.000	79) 80) 81)	— — —	79) 80) 81)	555.000 554.000 568.000
437.800	398.000	1.990.000[9]	79) 80) 81)	696.500[8] 875.600[10] 1.094.500[14]	79) 80) 81)	537.300 537.300 577.100	79) 80) 81)	517.400 557.200 656.700	79) 80) 81)	417.900 517.400 557.200	79) 80) 81)	2.169.100[8] 2.487.500[10] 2.885.500[14]

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Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction: Inside plant	Actual 1978 construction: Outside plant
Asia				
Bahrain	132.418	19.965	8.593	12.450
Brunei	31.795	3.540	.560	.563
China/Taiwan	1,279.543	439.777	107.536	91.010
Cyprus	21.098	23.100	3.563	1.632
Hong Kong	486.915	238.978	25.816	9.069
Israel	2,170.000	n/a		
Japan	n/a	15,154.000[8]	n/a	n/a
Kuwait	259.611	36.600	27.093	16.786
Nepal	6.894	3.140	197	.026
Philippines				
Philippine Long Distance Tel. Co.	397.000	100.000	25.000	10.000
Republic Tel. Co.	51.413[11]	4.744	2.945	1.815
Qatar	n/a	n/a	n/a	n/a
Telecom Singapore	412.090	124.310	16.390	36.040
Thailand	386.160	83.460	19.131	19.057
Africa				
Ethiopia	15.400	22.220		
South Africa, Republic of	1,870.121[9]	544.743	67.645	178.173
Zimbabwe Rhodesia	100.200	47.709[16]	4.660	4.400
Oceania				
Australia	10,264.000	2,200.000	216.700	313.700
Fiji	43.618	10.235	.577	1.174

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside Plant		Outside Plant		Station apparatus		Other		Total
2.790	27.230	51.063	79)	11.167	79)	10.058	79)	3.196	79)	29.531	79)	53.952
			80)	10.629	80)	7.944	80)	3.790	80)	21.533	80)	43.897
			81)	4.058	81)	7.324	81)	2.798	81)	16.366	81)	30.546
.280	.465	1.480	79)	6.136	79)	6.668	79)	.685	79)	10.597	79)	24.086
			80)	2.409	80)	1.909	80)	1.136	80)	3.932	80)	9.386
			81)	2.636	81)	1.273	81)	1.591	81)	4.523	81)	10.023
13.939	74.627	287.112[7]	79)	113.509	79)	122.482	79)	20.463	79)	104.940	79)	361.394
			80)	151.390	80)	169.040	80)	27.824	80)	144.458	80)	492.712
			81)	216.921	81)	213.356	81)	32.135	81)	182.190	81)	644.602
1.755	.462	7.414	79)	11.404	79)	7.554	79)	2.230	79)	2.145	79)	23.335
			80)	10.928	80)	8.447	80)	3.855	80)	5.566	80)	28.800
			81)	11.200	81)	8.400	81)	2.800	81)	4.200	81)	26.600
6.585	6.678	48.148	79)	38.917	79)	12.991	79)	3.780	79)	13.505	79)	69.192
			80)	70.590	80)	10.123	80)	6.566	80)	30.247	80)	117.527
			81)	81.657	81)	10.631	81)	8.910	81)	38.445	81)	139.645
		n/a									79)	n/a
											80)	n/a
											81)	n/a
n/a	n/a	7,846.000[9]									79)	7,742.000[8]
											80)	8,111.000[10]
											81)	n/a
6.786	2.791	53.456	79)	20.806	79)	37.450	79)	7.693	79)	9.863	79)	75.811
											80)	n/a
											81)	n/a
0	.070	.293	79)	4.039	79)	1.544	79)	.373	79)	1.909	79)	7.865
			80)	5.396	80)	1.292	80)	.010	80)	.617	80)	7.315
			81)	2.709	81)	.858	81)	0	81)	1.093	81)	4.660
7.000	11.000	53.000	79)	45.000	79)	22.000	79)	10.000	79)	24.000	79)	101.000
			80)	45.000	80)	34.000	80)	16.000	80)	34.000	80)	129.000
			81)	n/a	81)	n/a	81)	n/a	81)	n/a	81)	n/a
.315	.503	5.578	79)	8.709	79)	3.558	79)	.783	79)	.687	79)	13.737
			80)	3.453	80)	1.577	80)	.718	80)	.719	80)	6.467
			81)	2.138	81)	.977	81)	.455	81)	.455	81)	4.005
n/a	n/a	n/a									79)	18.000
											80)	30.000
											81)	20.000
10.770	12.710	75.910[16]	79)	33.838	79)	19.883	79)	13.704	79)	13.074	79)	80.499[9]
			80)	45.630	80)	29.539	80)	15.970	80)	21.810	80)	112.949[6]
			81)	53.320	81)	35.290	81)	17.350	81)	22.120	81)	128.080[10]
0.889	9.300	48.377[12]	79)	36.044	79)	7.296	79)	4.484	79)	13.513	79)	61.337
			80)	68.012	80)	17.814	80)	5.500	80)	45.868	80)	137.194
			81)	93.862	81)	53.993	81)	9.091	81)	75.310	81)	232.256
		n/a									79)	2.568
											80)	n/a
											81)	n/a
29.075	1.079	275.972	79)	203.108	79)	72.579	79)	35.406	79)	2.789	79)	313.882
			80)	221.522	80)	93.527	80)	45.989	80)	2.437	80)	363.475
			81)	235.241	81)	84.421	81)	53.000	81)	2.680	81)	375.342
2.071	1.910	13.042[15]	79)	8.104	79)	3.972	79)	1.921	79)	2.010	79)	16.007
			80)	13.537	80)	5.128	80)	2.986	80)	2.179	80)	23.830
			81)	10.019	81)	5.334	81)	2.857	81)	2.137	81)	20.347
172.600	61.800	764.800	79)	230.000	79)	330.500	79)	199.100	79)	67.000	79)	829.600
			80)	249.200	80)	343.100	80)	221.400	80)	82.600	80)	896.300
			81)	257.500	81)	343.000	81)	235.600	81)	96.300	81)	932.400
1.380	1.312	4.442	79)	1.323	79)	2.792	79)	.377	79)	.130	79)	4.622
			80)	2.345	80)	2.386	80)	.342	80)	.188	80)	5.262
			81)	1.705	81)	1.895	81)	.612	81)	.196	81)	4.409

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Table 2 World Plant Investment, Service Revenues and Construction Expenditures (continued)

excluding land and buildings ($ millions)

	Est. total telecom plant gross investment 12/31/79	Est. 1979 telephone service revenues	Actual 1978 construction	
			Inside plant	Outside plant
Guam	20.000	8.000	n/a	n/a
Mariana Islands	.500	.067	.050	.020
New Zealand	648.368	442.721[13]	19.770	16.440
Solomon Islands	n/a	.205		
Tonga	4.300	n/a	1.300	.700

Footnotes, Table 2

†not available
[1]Amount in U.S. $ millions, with exchange rate: 39 Chilean Pesos=US$1
[2]Amount in US $ millions, with exchange rate: 33.95 Chilean Pesos=US$1
[3]Book value
[4]Answers in Table 2 are for Finnish PTT only. For purposes of calculating world spending, TELEPHONY assumed PTT phones represented 25.22% of total Finnish phones (as in 1978).
[5]Not decided yet due to late parliamentary elections; most likely very similar to 1979
[6]July 1-June 30 financial year. In Sweden's case, 1977-78 and consecutive years thereafter
[7]Domestic telephone service only (also applies 1979-81)
[8]year ending 3/31/80
[9]year ending 3/31/79
[10]year ending 3/31/81

472,038,000 telephones.

Proceeding from these basic totals and the other information supplied by our respondents, we obtained the following Dec. 31, 1979 statistics.

Plant investment:

World non-U.S.	$197.042 billion
Bell System	120.321 billion
U.S. Independents	31.315 billion
World Total	$348.678 billion

Plant investment per station:

World non-U.S.	$663.44
Bell System	849.48
U.S. Independents	937.57
World Average	$738.67

Telecommunications revenues:

World non-U.S.	$86.651 billion
Bell System	45.050 billion
U.S. Independents	9.237 billion
World Total	$140.938 billion

Telecom revenues per station:

World non-U.S.	$291.75
Bell System	318.06
U.S. Independents	276.56
World Average	$298.57

In three years, that is, since the last time we made Investment and Revenue extrapolations, world non-U.S. plant investment has risen from $167.703 billion to $197.042 billion (TELEPHONY, Jan. 10, 1977); however, investment per station has actually dropped slightly from $669.47 at year-end 1976 to the above $663.44. (As our survey stands now, we ask for "Estimated Total Telecommunications Plant Gross Investment (excluding land and buildings), as of Dec. 31, 1979." We're realizing this does not sufficiently pinpoint the investment amount. Between now and next year's survey we'll be working with telecom industry advisers on a more exact definition.)

World (non-U.S.) operating revenues for '76 were $63.699 billion but for '79 were up to $86.651 billion. Revenues per station three years ago registered at $254.29 compared to the above $291.75. Inflation, of course, has been a big factor in the rise. How much is a highly complicated calculation, because so many nations are involved.

The top 15 construction spenders reporting to TELEPHONY outside the U.S. for 1980 are (in $ billions): Japan, 8.111; Germany, 4.06; United Kingdom, 2.488; Spain, 1.652; Bell Canada, 1.076; Australia, 0.896; Switzerland, 0.554; Austria, 0.500; Taiwan, 0.493; Sweden, 0.481; Norway, 0.461; Telefonos de Mexico, 0.383; Republic of South Africa, 0.363; Telefontilsynet (Denmark), 0.329; and Greece, 0.313.

Other countries we did not hear from, but which from past reports we could expect to be among the leaders, include (amounts again in $ billions): France, 5.498 (1979); Italy, SIP, 1.704 ('79); Netherlands, 0.391 ('78); Turkey, 0.388 ('79); and Telesp of Sao Paulo, Brazil, 0.339 ('79).

Then there is the $3 billion modernization project in Saudi Arabia on which the contract was signed in January 1978. The switching and related equipment part of the plan was to take three years; the operation and maintenance part, five years, and the whole was to

expenditures			Budgeted or estimated construction expenditures									
Station apparatus	Other	Total		Inside Plant		Outside Plant		Station apparatus		Other		Total
n/a	n/a	5.700	79) 80) 81)	2.500 1.600 .850	79) 80) 81)	10.000 3.400 6.700	79) 80) 81)	.200 .250 .225	79) 80) 81)	.300 1.350 .825	79) 80) 81)	13.000 6.600 8.600
.002	0	.072	79) 80) 81)	.030 .050 .050	79) 80) 81)	.020 .050 .050	79) 80) 81)	.006 .015 .015	79) 80) 81)	0 0 0	79) 80) 81)	.056 .115 .115
11.930	12.310	60.450[9]									79) 80) 81)	62.000[8] 62.000[10] 62.000[14]
		.200									79) 80) 81)	.374 n/a n/a
.015	.020	2.030	79) 80)	.200 .700	79) 80)	.400 .400	79) 80)	.100 .100	79) 80)	.150 .078	79) 80) 81)	.850 1.278 n/a

[11]As of 6/30/78
[12]Fiscal 1978, ending 9/30/78
[13]Total domestic and international telephone and record operating revenue for year ending 3/31/80. Includes est. domestic telephone service revenue (incl. inland toll revenue) of $361.047 (millions)
[14]Fiscal 1981, ending 3/31/82
[15]6/30/79; following amounts for succeeding fiscal years
[16]year ending 3/31/78
[17]Total construction expenditures for all years up to 12/31/78

Exchange rates:
Bahamas: BH $1=US$1.0125
Finland: FIM 3.739=US$1
Spain: Pts. 70.11=US$1 (1978 & 79)
Pts. 66.6=US$1 (1980 & 81)
Switzerland: SFr. 1.60=US$1

Taiwan: New T$36.00=US$1
Japan: Yen 209=US$1 (1978)
Yen 217=US$1 (1979-80)
Ethiopia: Birr 2.07=US$1

increase that country's telephone system from about 190,000 lines to 650,000 (TELEPHONY, Jan. 30, 1978).

A major enlargement of Indonesia's telephone network involves first the expenditure of $1 billion in the five-year plan concluded in 1979 to add 450,000 lines; then the addition of 500,000 more. (TELEPHONY, Oct. 22, 1979, p. 131).

From the foregoing Oct. 22 article comes a long-range Philippine spending forecast: private and government investment in telecoms is expected to total $340 million between 1978 and 1982, an amount likely to quadruple by 1987. Also, South Korea is investing $1.8 billion in communications between 1977 and 1982. In this latter country, Western Electric International, Inc., recently was selected to negotiate a five-year contract to provide nationwide electronic switching (TELEPHONY, Jan. 7, p. 13). WEI also would provide Korea with the technology needed to manufacture the switching gear in Korea.

Two other major contracts for te-

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Table 3 Overseas Telephone Service*

	Two way messages Quantity	Growth %		Two way messages Quantity	Growth %
1927	11,753	—	1953	1,440,317	5.6
1928	22,665	92.8%	1954	1,529,152	6.2
1929	30,323	33.8	1955	1,742,368	13.9
1930	33,821	8.2	1956	2,024,117	16.2
1931	33,253	1.3	1957	2,421,332	19.6
1932	27,971	(15.9)	1958	2,687,836	11.0
1933	30,195	8.0	1959	3,088,645	14.9
1934	26,665	(11.7)	1960	3,713,183	20.2
1935	28,059	5.2	1961	4,365,020	17.6
1936	48,429	72.6	1962	4,914,262	12.6
1937	75,010	54.9	1963	5,290,460	7.7
1938	75,058	.1	1964	6,382,127	20.6
1939	76,189	1.5	1965	8,108,030	27.0
1940	73,429	(3.6)	1966	9,931,918	22.5
1941	116,680	58.9	1967	12,332,231	24.2
1942	135,196	15.9	1968	15,166,091	23.0
1943	153,799	13.8	1969	20,800,303	37.1
1944	173,799	12.8	1970	26,305,694	26.5
1945	360,341	107.8	1971	32,245,147	22.6
1946	631,665	75.3	1972	40,225,532	24.7
1947	664,273	5.2	1973	47,478,563	18.0
1948	797,531	20.1	1974	59,878,146	22.8
1949	852,864	6.9	1975	71,662,752	19.7
1950	1,000,184	17.3	1976	87,140,523	21.6
1951	1,263,362	26.3	1977	109,599,014	25.8
1952	1,363,775	7.9	1978	149,521,467	36.5
			1979	190,829,000	27.6E

*Overseas in this context is defined as all calls to and from the 48 contiguous United States to all points outside these states, except to Canada and Mexico
E=Estimated
Source: Business Research-Long Lines Department, Long Lines Statistics. (Bedminster: American Telephone & Telegraph, 1979)

lecom expansion were announced during Telecom 79 in Geneva last September, the $1.8 billion five-year Egyptian transmission and switching contract awarded to Siemens of Germany, Thomson-CSF of France and Siemens of Austria; and the $500 million coaxial cable network contract award to an Italian consortium composed of Pirelli, Ceat, Telettra and SIRTI, by the Post & Telecommunications Corp. of Libya (TELEPHONY, Oct. 22, 1979, p. 65).

In this year's survey we asked for, and got, new kinds of information: Dec. 31, 1979 population estimates, which enable one to make up-to-date telephones per 100 of population estimates; number of households and businesses, which facilitate telecom density calculations in these two primary areas; and business and residence extensions for telephone user saturation ideas in these two sectors. Respondents were wonderfully helpful in these new respects as well as in furnishing again the extensive data requested in previous surveys. Were we to have made all the calculations possible based on old as well as new information, time to carry them out and space in this article would have been exceeded. (The column headed "Other," by the way, includes, for example, modems, housekeeping items, construction equipment, buildings, office equipment and furnishings, radio and remote switching terminals and concentrators.)

Once all this equipment is in place, how much is it used? One perspective on this question is the amount of international traffic originating and terminating in the 48 contiguous United States (see Table 3). In a word, the growth is phenomenal, and doesn't show any signs of leveling off. For the last three years, it has been climbing at better than 25% a year.

As we've seen, certain nations are going ahead with telecom expansion at an amazingly fast pace. Can they be thinking that telecom plant-invested money buys much more than just the equipment? As this writer sees it, it really does buy a communications capability that's going to keep these nations in the forefront of general technological advance, and contribute importantly to improving productivity country-wide. Up-to-date telecom equipment prepares a nation to deal with the information explosion, or the Information Age, as it's being called; enables it to furnish services for gathering and processing data plus the subsequent accessing capability. A PTT offering its customers the new sophisticated telecom devices is enabling them to compete more successfully in a world growing increasingly dependent on exporting. Such a country, too, is more ready to benefit domestically from all that telecommunications does to keep citizens, businesses and various other institutions in touch.

The world is well on its way to gaining these benefits—even though now, in early 1980, the progress is uneven. □

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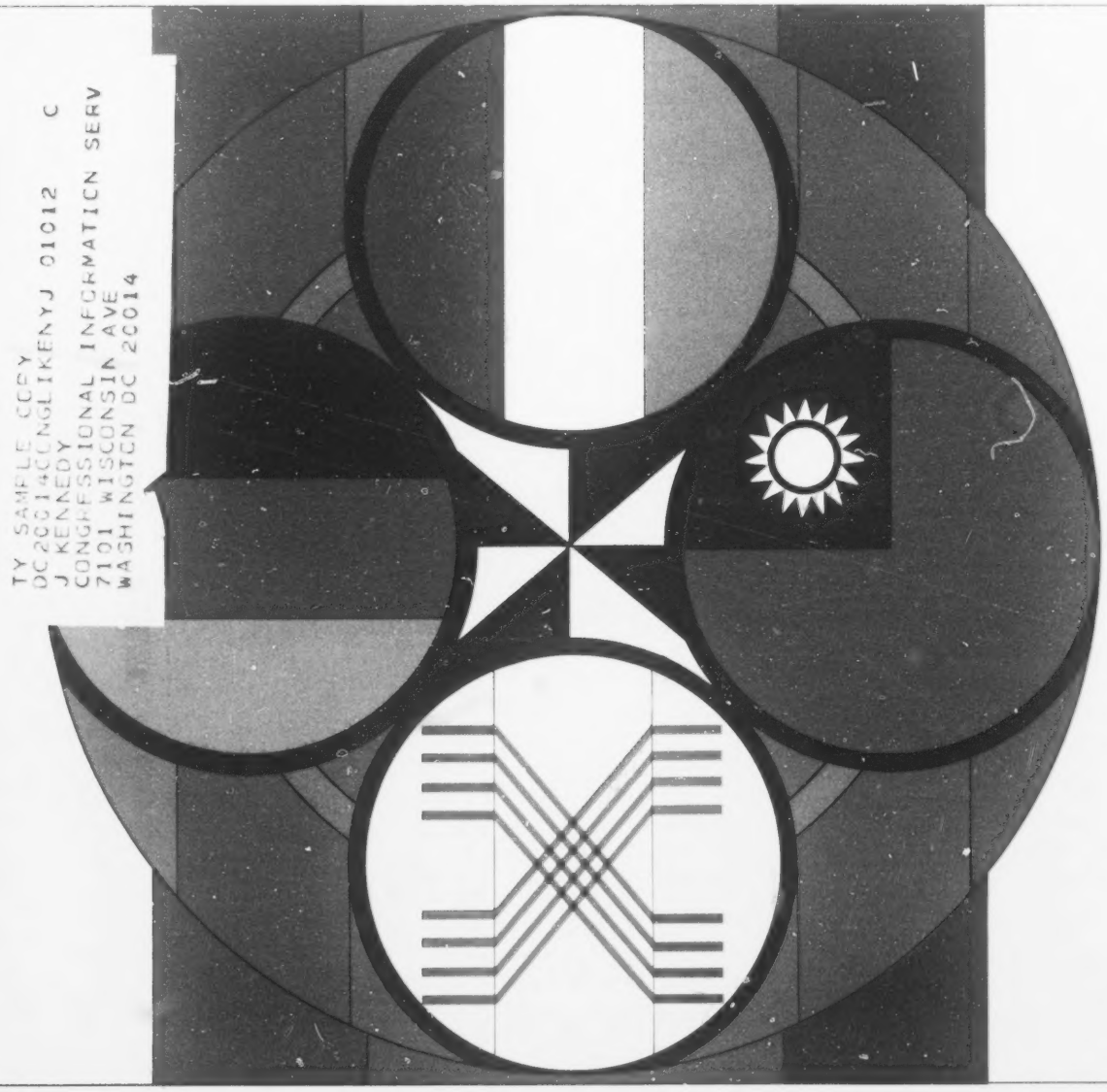

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T. C. CHIANG

Supplying the demand

During the past decade, the Taiwan Telecommunications Administration has had to cope with a 20% annual growth rate. Here, Managing Director T. C. Chiang discusses the continuing evolution in central office switching plant which is enabling the island community to keep up with demand

DURING THE 1970s the number of telephones in Taiwanese cities increased at the rate of 20% per year; this trend is expected to continue at only a slightly diminished pace during the 1980s. Electronic switching systems (ESSs), the ITT (International Telephone & Telegraph Corp., New York, N.Y.) Metaconta 10C and the GTE (General Telephone & Electronics Corp., Stamford, Conn.) No. 1 EAX are currently being introduced. By September 1979 eight ESS exchanges were in operation, accounting for 10% of the public service lines in Taiwan. This figure will rise to 26% by 1987. Fully digital switching systems are planned both for the toll network and for local exchanges. The majority of the ESS equipment is being manufactured in Taiwan, and local engineers are performing installation, operation and maintenance functions.

During the last decade, continuing economic prosperity and rising income levels due to Taiwan's rapid industrial and commercial development have caused ever increasing demand for telephone service. To meet this pressing demand, the Taiwan Telecommunications Administration (TTA) has made a maximum effort to increase telephone installations. As a result, the number of telephone subscribers in cities has increased from 182,788 in July 1969 to 1,689,724 in July 1979—an increase of 820%. The number of telephones has grown from 307,023 sets in 1969 to 2,341,469 sets in 1979—an increase of 660%. This sustained growth at a rate of more than 20% a year over a decade is indeed an unprecedented phenomenon. Tables 1 and 2 show the year-by-year growth in subscribers and telephones since 1969.

In 1976 the TTA initiated a six-year, medium range development plan. In order to meet the urgent and rising demand for telephone service, it has been necessary to revise upward the estimates for the last two years of the planning period (1980-1981). The target increases in new subscriber installations have now been set at 420,000 for fiscal 1980 and 620,000 for fiscal 1981. Therefore, at the end of the first six-year development plan the projected total number of subscribers and telephone sets will show 14.4 and 11.6 times increases respectively over the 1969 figures. By July 1981 the number of telephones per 100 persons in Taiwan is expected to reach 19.9. Table 3 shows the projected growth in number of subscribers for fiscal 1980 and 1981.

Table 4 shows the projected growth in number of telephones for fiscal 1980 and 1981.

Based on telephone statistics from 115 representative countries worldwide, a regression relationship can be established between telephone density and average per capita income. If Q represents the number of telephones per 100 persons and X represents the average per capita income in U.S. dollars, we have:

$$\log(Q) = 1.25 \log(X) - 3.27$$

The soundness of this regression relationship is borne out by the very high correlation coefficient of 0.91. Given that the average per capita income in Taiwan in 1977 was $1180, the regression equation yields a telephone density of 3.7 per 100 persons. However, the actual telephone density in Taiwan in 1977 was about 10, which far exceeds the number based on the worldwide regression relationship. This is a very unusual, but persistent, phenomenon.

In drawing up the preliminary plans for development during the second six-year period, 1982-1987, the Administration has considered a number of factors both internal and external to its operation. The internal factors include the Administration's financial and human resources, investment return rates, capabilities of suppliers, its role in guiding and assisting the development of local suppliers, and timing considerations. The external factors include Taiwan's economic growth rate and structure trends, income level and distribution, family size, subscriber behavior patterns, the characteristics of a matured telephone network that is approaching saturation, telephone installation and usage charges, and projected demand. In addition, the TTA has considered the relative role and impact of telecommunication development in the overall national economic development.

Our preliminary plans for the second six-year development period are based on the following assumptions: the number of subscribers will increase at an average annual rate of 16.4%, reaching a total of 8.6 million by 1987. Telephone density will reach 43.9 per 100 persons, or 0.81 per household.

Prior to 1969, almost all of the automatic exchanges installed in Taiwan were of the Strowger or Siemens Halskey step-by-step

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T. C. Chiang is Managing Director of the Taiwan Telecommunications Administration. This article has been adapted from a presentation made at CommunicAsia held in Singapore last December.

type, procured from both local and foreign suppliers. Beginning in 1969, the Administration began to introduce C-400 electromechanical crossbar exchanges on a large scale. This undertaking was based on the policy decision to upgrade domestic telecommunication technology and to implement domestic direct subscriber toll dialing totally.

During the early days of our crossbar installation program, most of the material and equipment items were imported. But as the two local factories increased their manufacturing capabilities, we have within the last few years switched almost completely to local procurement of crossbar equipment. And as a result of the abundant demand, adequate supplies at economical cost, and the ample availability of Administration resources, we have achieved the phenomenal growth in the Taiwan network that was described earlier.

The next stage in the progress of switching technology was provided by the Administration's decision to introduce stored program controlled electronic switches into the Taiwan network. Since the successful trial of the first Bell System electronic switch in 1960, rapid and significant advances in electronic and computer technology have led administrations in most of the advanced countries to develop and adopt on an increasingly wide scale electronic switching systems that meet their needs.

We have all seen the development of the Bell electronic switching systems, the ITT Metaconta systems, the GTE EAX systems, the Japanese D10 and D20 systems, and many other European and American systems. Switching technology has improved from semielectronic matrix to fully electronic, from centralized stored program control to distributed control and from analog to digital switching. Although electronic digital switching is certainly the wave of the future, present digital systems seem to require additional development before they reach maturity.

Even though, due to our particular circumstances, electronic

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Table 1

Fiscal Year	Increase in No. of Subscribers	Cumulative Total	Growth Rate(%)	Index
1969	33,168	182,788	22.2	100
1970	44,183	226,971	24.2	124.2
1971	51,721	278,692	22.8	152.5
1972	61,862	340,554	22.2	186.3
1973	87,125	427,679	25.6	233.9
1974	111,478	539,157	26.1	294.9
1975	146,975	686,132	27.3	375.4
1976	200,447	886,579	29.2	485.0
1977	205,870	1,092,449	23.2	597.7
1978	257,959	1,350,408	23.6	738.8
1979	339,316	1,689,724	25.1	924.4

TABLE 1 *Subscriber growth, 1969-1979.*

Table 2

Fiscal Year	Increase in No. of Telephones	Cumulative Total	Growth Rate(%)	Index
1969	52,407	307,023	20.58	100
1970	64,595	371,618	21.04	121
1971	71,373	442,991	19.21	144
1972	97,229	540,220	21.95	176
1973	122,526	662,746	22.68	216
1974	158,266	821,012	23.88	267
1975	189,016	1,010,028	23.02	329
1976	249,539	1,259,567	24.71	410
1977	284,152	1,543,719	22.56	503
1978	347,325	1,891,044	22.50	616
1979	450,425	2,341,469	23.82	763

TABLE 2 *Growth in number of telephones, 1969-1979.*

Table 3

Fiscal Year	Projected Increase in No. of Subscribers	Projected Cumulative Total	Growth Rate(%)
1980	420,000	2,109,724	24.9
1981	520,000	2,629,724	24.6

TABLE 3 *Projected increase in number of subscribers, 1980 and 1981.*

Table 4

Fiscal Year	Projected Increase in No. of Telephones	Projected Cumulative Total	Growth Rate(%)
1980	550,531	2,892,000	23.5
1981	679,000	3,571,000	23.5

TABLE 4 *Projected increase in number of telephones, 1980 and 1981.*

switching has not become competitively cost-effective or technically advantageous, we nevertheless decided to start adopting electronic switching because of its many operating and network advantages over electromechanical crossbar switches. Some of the advantages of electronic switching are its versatility and flexibility of operation, availability of new features, manageability of the network, ease and completeness of maintenance, and extended service life.

The energy- and space-saving advantages of electronic systems are not lost on us, particularly in today's environment where energy and urban land are becoming increasingly scarce. Continuing advances in electronic and computer technology should make electronic switching systems even more versatile and cost effective.

Finally, the introduction of electronic switching is also a way for the Administration to fulfill its objective of promoting the development of the domestic electronics industry. Our aims are to upgrade our technology, to computerize our operations and to modernize our management practices.

The Directorate General of Telecommunications (DGT) decided to adopt electronic switching as a way to catch up technically with the advanced countries, to respond to domestic economic development needs and to assist the development of a high-technology electronics industry. The vehicle through which electronic switching was to be introduced into Taiwan was the establishment of two joint-venture factories, based on agreements reached in 1973 with ITT and GTE.

The ITT-DGT joint venture, Taiwan International Standard Electronics Ltd. (TAISEL) started delivering ITT Metaconta IOC equipment late in 1976. The GTE-DGT joint venture, GTE Taiwan Telecommunications Ltd. (GTETTL) commenced delivery of GTE No. 1 EAX equipment in mid-1977. Presently, both factories have reached a production rate of 100,000 lines per year. By the end of 1979 TAISEL will start producing the Metaconta IOCN system; GTETTL is considering the introduction of its No. 2 EAX system late in 1980.

The original DGT agreements with ITT and GTE stipulated that, beginning in 1974, the Administration would place five yearly orders with TAISEL for a total of 370,000 lines of switching equipment, and five yearly orders with GTETTL for 280,000 lines of switching equipment. The delivery schedule is presented in Table 5.

The actual installation and cutovers of the equipment have been somewhat delayed due to a combination of procurement, implementation and site availability problems. The actual (1976-1980) and projected (1981-1982) cutover schedules of the 650,000 lines are presented in Table 6.

'Recent trends in the development of telecommunications technology and the information revolution clearly show . . .an integrated digital service network is a must for the future.'

As of the end of September 1979, eight electronic exchanges totaling 180,000 lines had been cut into service. Three more exchanges, totaling 80,000 lines, were to be cut over by year-end, bringing the total lines in service to 260,000. This accounts for about 10% of the total public service lines in Taiwan. By the end of the first six-year development period in June 1981, the total number of ESS lines in service is projected to reach 450,000 lines, about 12% of the total.

ESS switching procurement and installation as a percentage of total public lines are targeted to increase during our second six-year, medium range development period (1982-1987), based on preliminary plans. ESS lines are projected to account for 26% of the total by the end of fiscal 1987 (June 1987). The actual implementation of the plan will of course be influenced by such factors as stability of supply, relative prices, the Administration's own resources and changes in the general economy.

In order to assure the complete and correct transfer of ESS technology, the original DGT agreements with ITT and GTE specified local integration programs for TAISEL and GTETTL. Taiwanese engineers were sent overseas for training. In addition, the first orders were procured directly from GTE and ITT-BTM (Bell Telephone Manufacturing, Antwerp, Belgium), to insure on-time cutover and to provide the opportunity for hands-on installation and training activities by local personnel.

Starting with the second orders, deliveries were made from TAISEL and GTETTL with increasing local content. TAISEL's local manufacturing integration has reached approximately 80%, with all design work being performed by local engineers. Also starting with the second orders, the Administration began sharing the installation and test responsibilities in some of the non-turnkey exchanges.

The Administration has placed an order with Western Electric Co., New York, N.Y., U.S., for the turnkey supply of a Bell No. 4 ESS

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Table 5

System	First Order	Second Order	Third Order	Fourth Order	Fifth Order	Total
No. 1 EAX	30,000	40,000	40,000	70,000	100,000	280,000
IOC	20,000	50,000	90,000	100,000	110,000	370,000
Total	50,000	90,000	130,000	170,000	210,000	650,000

TABLE 5 *Directorate General of Telecommunications/Taiwan Telecommunications Administration electronic switching systems procurement plan (number of lines).*

digital switch initially having 16,000 both-way trunks. Another order has been placed with ITT North Electric Co., Johnson City, Tenn., U.S., for 16,000 lines of ITT 1210 digital containerized local switching systems. The procurement of an additional 40,000 lines of digital containerized local switches is planned.

The decision to install the Bell No. 4 ESS digital toll switch was made after consideration of the rapidly expanding toll switching needs of the Taipei area (where there are already over 700,000 telephone subscribers), the inadequacy of the traditional C-82 crossbar toll switch, the maturity of digital toll switching technology and the relative ease of starting digitalization at the toll level. The No. 4 ESS switch is scheduled for cutover in the Taipei area in June 1981.

Our purchase of the ITT 1210 digital containerized exchanges was based on two separate considerations. The need for trailer exchanges was not new; we had been installing crossbar trailer exchanges in locations where either a permanent site was not available, or the installation of conventional equipment was impractical. The decision to purchase some digital trailer exchanges was prompted by our realization that despite the fact that large digital local switching systems are not yet mature, the future definitely belongs to digital switching. We therefore decided to purchase the 4000-line digital trailer switches both to meet our urgent demand, and to give ourselves the opportunity to investigate in depth the technology and operation of digital switching. The four ITT 1210 digital trailer switches are to be put into service by the end of 1980. Although we do plan to import 10 additional 4000-line digital trailer exchanges, our long-term planning calls for the development of local supply on a large scale.

The initial installed costs of stored program controlled electronic switches started out at about twice the installed cost of crossbar exchanges. This additional cost placed an extra burden on TTA's financial resources. But because electronic switching systems have made up a relatively minor percentage of our total installation, the extra burden has not been too difficult to bear. However, as we plan for increasingly larger percentages of ESS installations, the relative cost-effectiveness of ESS and crossbar must converge, so that the extra burden is gradually reduced. This can be brought about only by a reduction in the cost of ESS equipment. Relative costs and Administration resources also will be important considerations when we come to make the digital local switching decision.

As regards human resources, TTA sent 40 engineers to ITT-BTM and GTE for training during the early days of the introduction of Metaconta IOC and No. 1 EAX. After completing their training, these engineers participated in on-site installation and testing activities. Furthermore, they joined our Telecommunication Training Institute training programs in order to assist in the training of other TTA personnel. Today we are confident that TTA can adequately operate and maintain our ESS exchanges.

Because of their versatility and flexibility, electronic exchanges can very economically provide a number of operational facilities for the Administration and service features for the subscriber. In Taiwan, we have made the following new service features available:

- *Direct international dialing.* As of Nov. 1, 1979, we had already opened direct international dialing between Taipei and the U.S. mainland, Hawaii, Japan, Hong Kong, Singapore, Australia, Canada, Italy, Switzerland and Spain. We will provide direct international dialing to other countries from additional points within Taiwan.
- *Local automatic message accounting.* This not only provides more accurate records, but also improves responses to subscriber inquiries, thereby avoiding unnecessary confusion.
- *Abbreviated dialing.*
- *Call waiting.*

There are several other service features available from ESS exchanges which have not yet been offered to our subscribers. These include call forwarding, three-way calling, conference calls, wake-up service, do-not-disturb service, hot line and Centrex CO (central office).

One of the important considerations in our original decision to bring electronic switching to Taiwan by establishing local factories was to promote and stimulate the development of a technology-intensive electronics industry. This has proven to be a very sound decision as more and more of the components used in ESS equipment have become available from local suppliers.

Also, the high quality required of ESS equipment has served to improve the quality standards at some of our local manufacturers of electronic components. The need for software design in ESS equipment has provided a good training ground for the development of our software capabilities.

Recent trends in the development of telecommunication technology and the information revolution clearly show that the establishment of an integrated digital service network is a must for the future. We have already started to digitalize our transmission medium, through large scale placement of PCM (pulse code modulation) transmission equipment. Digital switching, both at the toll and the local level, also is included

Continued on page 112

Table 6

System	1976	1977	1978	1979	1980	1981	1982	Total
No. 1 EAX	20,000	10,000	—	80,000	40,000	90,000	40,000	280,000
IOC	—	20,000	50,000	80,000	70,000	100,000	50,000	370,000
Total	20,000	30,000	50,000	160,000	110,000	190,000	90,000	650,000

TABLE 6 *Actual (1976-1980) and projected cutover schedules for electronic switches (no. of lines).*

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We have started to digitalize our toll switching operations, but the present status of digital local switching does not permit us to begin adopting it. In the meantime, because of the pressing demand in our society for telephone services, we must continue to install analog switches on an increasingly larger scale, until digital local switching becomes practical. Before long, it will become necessary to plan the integration of the digital equipment into the analog network. The implementation and operation of this hybrid analog digital network will require careful and constant attention on the part of our Administration.

Based on my personal experience and reflection, I believe that a number of important factors must be carefully considered and evaluated before a developing country or region decides to introduce electronic switching technology. These are:

1) The high initial cost in the early days of ESS introduction, and its impact on the administration, must be carefully evaluated and planned for.

2) Very high initial installation charges to subscribers constitute a major source of funds for the administration in a developing region. These funds, however, must be used for capital investment purposes, and not treated as operating income.

3) A comprehensive long-term investment plan is a cornerstone of the introduction of ESS technology. The administration must take the initiative in formulating the method and timing of the introduction of the technology.

4) Administration personnel must participate fully in the introduction of electronic switching, regardless of the type and time.

5) A prerequisite to the introduction of ESS technology is the upgrading of the skills of technical personnel within the administration. In particular, the training of software personnel is of vital importance. A telephone administration must ensure that software capability already exists, or will be introduced, as a part of any plan to introduce electronic switching. □

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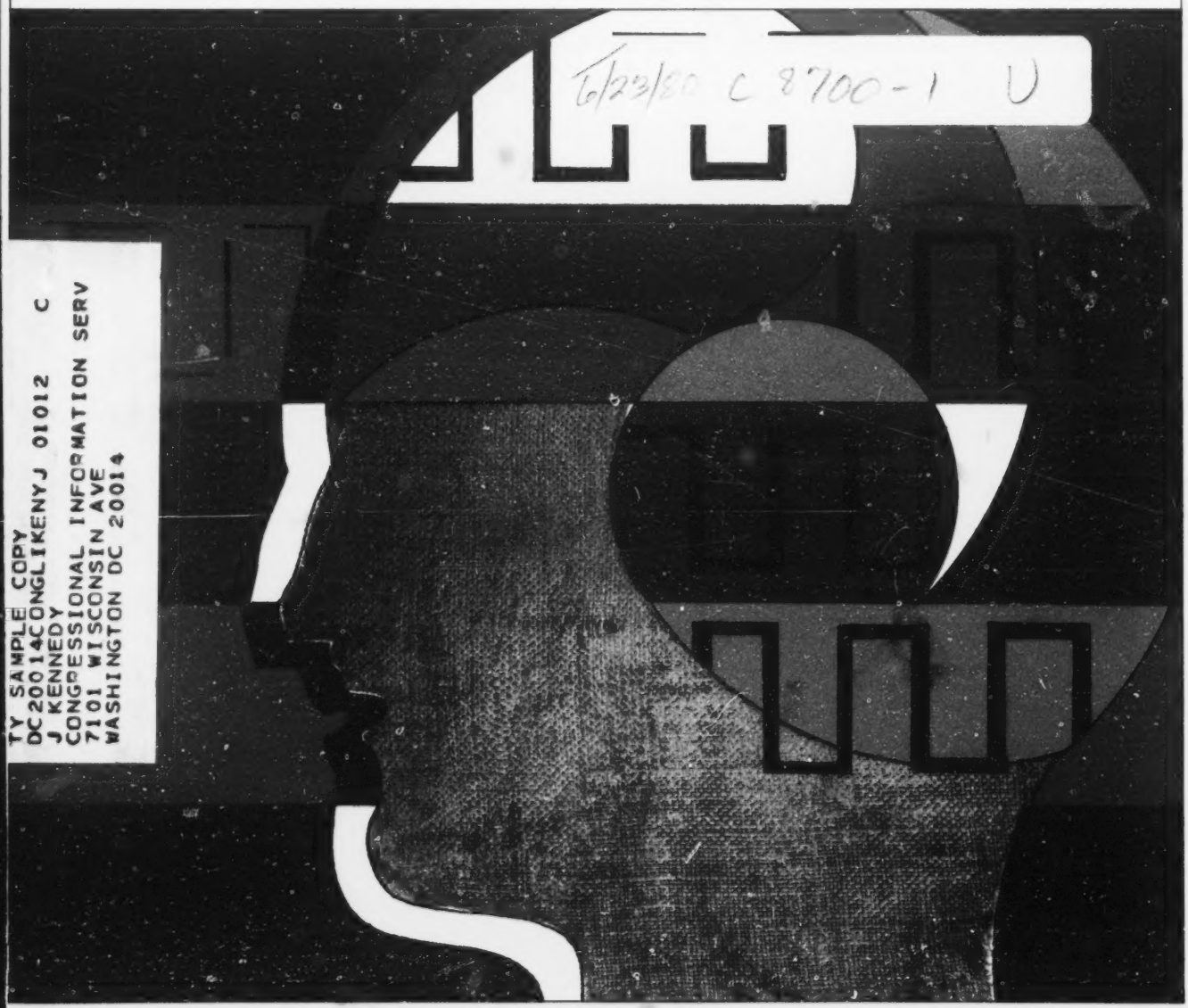

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Continental Telephone's digital experience

With 100 digital COs in place, Continental sees fewer troubles, but things still could be better

The extensive digital experience of Continental Telephone Corp. is explored in this two-part article. Part 1, which begins on these pages, covers implementation progress, the influence of digital on network design, and hardware considerations and experience. Part 2, which will appear in an early issue of TELEPHONY, *will cover software considerations and experience, network considerations and experience, future requirements and an overall assessment of the company's experience to date.–Ed.*

B.M. BARBE, R.G. DeWITT and R.L. SKELTON

A GENERALLY accepted definition of "digital switching" is the transmission of digital signals through a switch in which the signal path is established by either space division or time division. In this article the terms *digital switching* and *digital switch* will be used in place of *time division digital switching* and *time division digital switch*, respectively.

In 1970, the world's first digital switch was placed in telephone service in Lannion, Brittany, France. In January 1976, the Bell System's first No. 4 ESS (electronic switching system) in Chicago was the first digital switch in service in the United States. Three months later Continental Telephone became the first Independent telephone company with a digital switch in service. It was a TRW Vidar IMA-2 in Ridgecrest, Cal. Thus, Continental Telephone was an early supporter of digital switching and remains committed to that technology.

The advantages of digital switching in conjunction with digital transmission no longer are debatable. Briefly stated, they are:

Lower cost;

Less space required;

Provides the opportunity to integrate services;

Digital trunks eliminate channel banks for additional savings;

Trunk maintenance on a group basis;

Remote switch concept achieves additional savings by having the administration and maintenance capabilities at the host switch;

New services bringing additional revenue can be added more easily with less cost;

Remote switches in the subscriber plant reduce costs of the feeder cables.

A goal that is realizable during

ALL THREE authors are with Continental Telephone Service Corp. BRUCE M. BARBE is Director-Network Planning, Merrifield, Va.; RUSSELL G. DeWITT is Director-Technology Assessment, Merrifield, Va., and RONALD L. SKELTON is Director-Network Design, Atlanta, Ga.

Tabie 1

Class 4

TRW Vidar ITS 4

Northern Telecom DMS 200

Class 5

TRW Vidar ITS 5 & 4/5

Northern Telecom DMS 10

Stromberg-Carlson DCO

NEC America NEAX61

Table 2
Number of digital switches in service and on order by office class as of year-end 1979

Office class	In service	On order	Total
4	14	2	16
4/5	5	16	21
5 Host	59	61	120
5 Remote	15	80	95
Totals	93	159	252

the decade of the '80s is the Integrated Services Digital Network (ISDN) on which voice, enhanced voice, and all conceivable non-voice services except broadcast television will share common switching and transmission facilities and do it in a cost-effective way. In the past it was necessary to build separate networks for different services because analog transmission and switching did not provide the flexibility required to do otherwise. Now that the rapid spread of digital transmission and digital switching is a reality, the opportunity to provide a common network finally exists.

Implementation progress

As shown in Figure 1, Continental Telephone has about 1800 local office (class 5) switches and about 100 toll office (class 4) switches. Prior to 1976, these switches were predominantly electromechanical. Thus, the opportunity to skip the electronic analog switching stage of evolution and go directly to digital switching was presented. Studies showed that it would be cost-effective to do this in the latter part of the '70s and that the savings would be even greater in the '80s as the percentage of direct digital terminations grew. Also, the ability to offer new services possible only with an all-digital network would be a bonus sometime in the future.

Table 1 shows the different types of digital switches currently in service; Table 2 shows the number of digital switches in service and on order by class as of year-end 1979. The total of 93 in service (now there are more than 100) is the largest number for any single carrier in North America. By the end of 1981, 37, or 37%, of the class 4 switches will be digital. At the same time, 236, or 13%, of the local switches will be digital. Table 3 shows the breakdown of the switches in service by manufacturer. At the end of 1979, Continental Telephone accounted for approximately one-third of the U.S. total for three of the four suppliers shown. The approximate U.S. totals for these four suppliers at the end of 1979 are shown in Table 4.

While the number of digital switches in service is growing, so, too, is the amount of digital transmission. More than 50% of Continental Telephone's trunks are on digital

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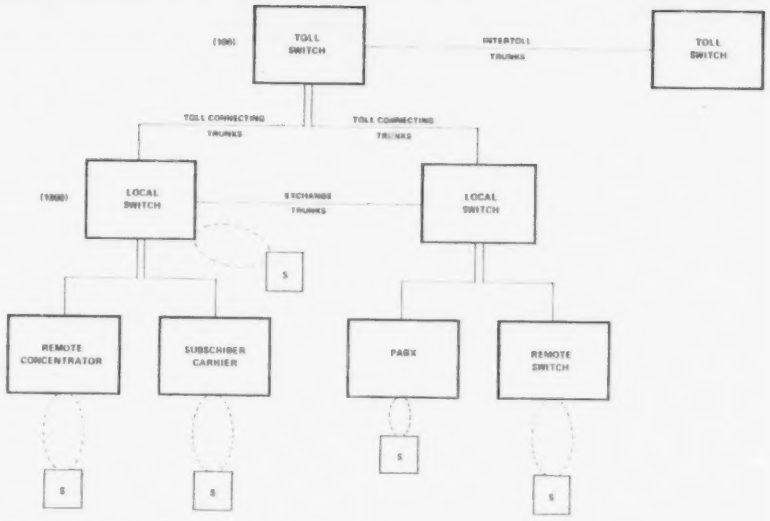

FIG. 1 *Network block diagram.*

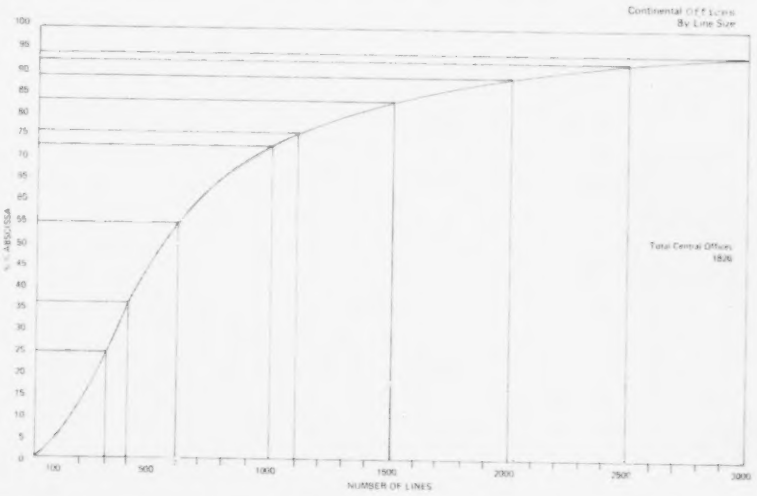

FIG. 2 *Cumulative distribution for Continental office sizes.*

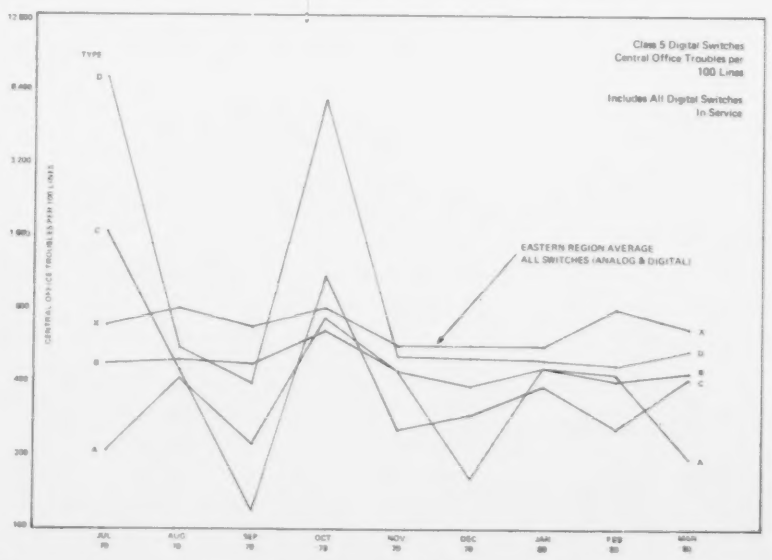
Class 5 Digital Switches Central Office Troubles per 100 Lines
Includes All Digital Switches In Service
EASTERN REGION AVERAGE ALL SWITCHES (ANALOG & DIGITAL)

FIG. 3 *Class 5 switches, CO troubles per 100 lines.*

Table 3
Number of CTC digital switches in service as of year-end 1979

	Offices	Percent of U.S. total	Remotes
Northern Telecom	38	32.5	
TRW Vidar	30	37.0/33.3	15
Stromberg-Carlson	6	9.5	
Nippon Electric	4	36.4	
Total	78	28.7	

Table 4
Number of digital switches in service as of year-end 1979

	Offices	Lines	Remotes
Northern Telecom	117	170,000	0
TRW Vidar	81	54,000	45
Stromberg-Carlson	63	94,000	0
Nippon Electric	11	40,000	0
Total	272		45

transmission facilities which include T1 carrier on copper cables, digital microwave radio and digital transmission on optical fiber cables. About 5000 PCM (pulse code modulation) channel banks have been installed. It is interesting to note that as the digital network becomes more integrated, a point will be reached at which new PCM channel banks will not be required because reuse of displaced channel banks will satisfy growth requirements.

This may begin to occur in about two or three years from now.

Network design

Figure 2 is a plot of the cumulative distribution for Continental Telephone office sizes in terms of total lines. It shows that 72.4% of the offices have 1000 lines or fewer, 88.7% of the offices have 2000 lines or fewer, and 94.2% have 3000 lines or fewer. Thus a 3000-line switch would satisfy most of the needs if the old concept of separate, independent offices was retained. However, the digital approach made possible a new concept of remote switches slaved to host switches, centralizing most of the intelligence and maintenance. This is more cost-effective today. Another name for this concept is *distributed switching*.

History has a way of repeating itself. At one time, computer users were trending toward centralized large mainframes, then when the minicomputer and microprocessor appeared with lower unit cost, the pendulum swung in favor of distributed computing. There is a trend toward distributed switching now for similar reasons. Therefore, a host switch is needed that will accommodate an aggregate of at least 12,000 lines made up of host lines plus the lines terminated on a number of remote switches which can accommodate up to 1000 lines each. Such a remote switch size will accommodate almost three-quarters of the offices. Offices with more than 1000 lines are likely host switch candidates.

Some of the remote switches will be placed in the feeder cable plant to avoid the cost of new feeder cable. Also, digital subscriber carrier with a direct digital interface with the remote switches will be used to effect additional savings by extending further out to low density rural areas. The goal is to establish digital islands in various parts of the network. A "digital island" is defined as an area in which two or more digital switches, which may include one or more remote switches, are interconnected by digital trunks on copper, glass or microwave radio of either the terrestrial or satellite variety. Each year as additional construction is completed, these islands grow a little larger. Eventually these islands will start to meet either by physically running into each other or by means of long haul digital connectivity and form still bigger islands. This process will not end until the core network is digital across the entire country, approximately in 1995. Another aspect of a digital island is network synchronization; the switches in a digital island all are synchronized to the same clock.

Two strategies were available for the introduction of digital switching into the network: one was to co-locate digital switches with the electromechanical switches; the second approach was to replace the electromechanical switches and reuse the removed equipment in other electromechanical offices. This eliminates the need to purchase additional equipment that is rapidly rising in cost because of the high production labor content and the falling production quantity. It was very clear that the latter course was best. As a result an extensive replacement and reuse program has been underway. During 1980 approximately 80% of the analog switching equipment requirements will be met through the Reuse Program. This approach also has been called *mature system containment* in some circles.

As previously discussed, savings can be realized by the consolidation of numbers of central offices in host-remote configurations. Recognizing that about 40% of the construction budget is spent on outside plant, further steps can be taken to realize additional savings in the subscriber cable plant. By using remote switches in the feeder cable plant instead of adding more physical cable, considerable savings can be attained.

Recent network studies on exchanges in Pennsylvania and North Carolina show the typical savings that can and are being realized. In three exchanges in Pennsylvania, a first cost savings of about $900,000 is being attained by the use of nine remote switches. In North Carolina the first cost savings in 14 exchanges will be about $2.8 million.

In order to achieve these savings, suitable host-remote switch architecture and packaging must be available. Only one manufacturer has a remote switch designed and packaged for outside plant use; only one other manufacturer has immediate plans to provide this type of packaging. Most applications in the subscriber outside plant can be satisfied by a remote switch which will serve approximately 500 lines and is housed in a one- or two-cabinet configuration. However, in some localities there is resistance to a cabinetized remote

switch. This resistance increases if the remote units are housed in a hut or trailer. Unfortunately, no manufacturer has stepped forward with a solution to the problem. One possible solution would be to place the unit underground. This would solve problems of esthetics, security and perhaps even the need to purchase or lease land.

Hard look at hardware

There are many different aspects of digital switch architecture that must be considered in any comparison. Among them are: byte or bit switching, digital or analog concentrators, type of switching network (TST or STS or other), nonblocking versus some blocking in the non-concentrating portion of the switching network, availability of a remote switch with a housing suitable for outside plant use, stand-alone capability of the remote switch, processor capability in terms of busy-hour call attempts that can be handled, system size in terms of number of terminations including lines, trunks and service circuits, call-carrying capacity in erlangs or CCS, memory for call store and data store, overload behavior, the codec arrangement is per-line or common to N lines, internal bit rates, environmental limits, power required, physical size.

When selecting a digital switch it is vitally important to be aware of design limitations that later can cause operating difficulties or problems in absorbing growth and feature additions. For example, it was discovered that with one type of digital switch the maximum number of terminations is reduced drastically when custom calling features are added. This can cause the exhaust point to be reached much earlier than planned. This same switch also caused RF radiation from subscriber cables at one location and went down completely at another location when a door was opened, letting in cold outside air.

Table 1 shows the different types of switches currently in service. With regard to the above list of architecture options, each version of the first four items is employed in at least one type of digital switch. For example, the DMS-10 and DCO use bit switching, whereas all the others use byte switching. The NEAX-61 uses an analog concentrator, while the others use digital concentra-

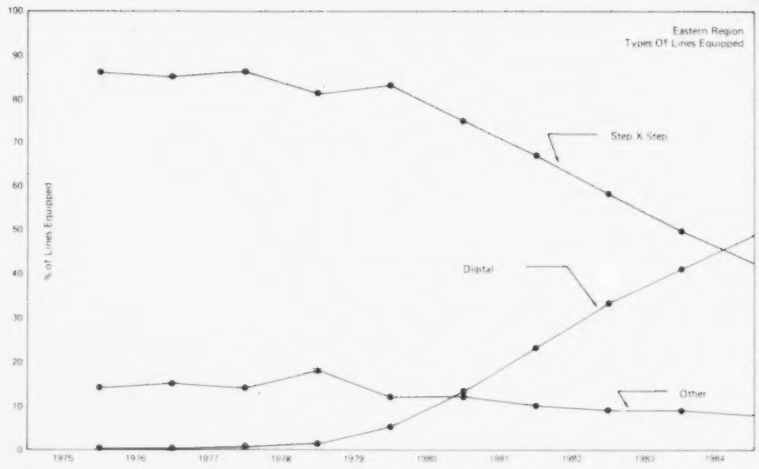

FIG. 4 *Eastern Region, types of lines equipped.*

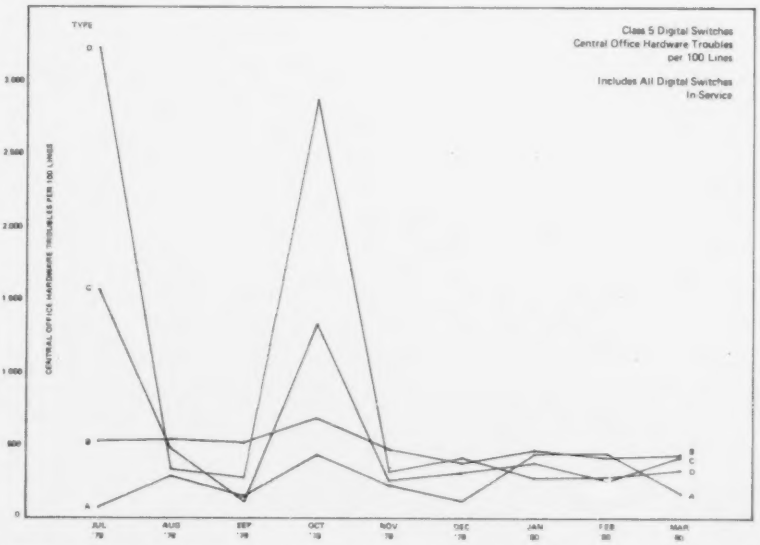

FIG. 5 *Class 5 digital switches, CO hardware troubles per 100 lines.*

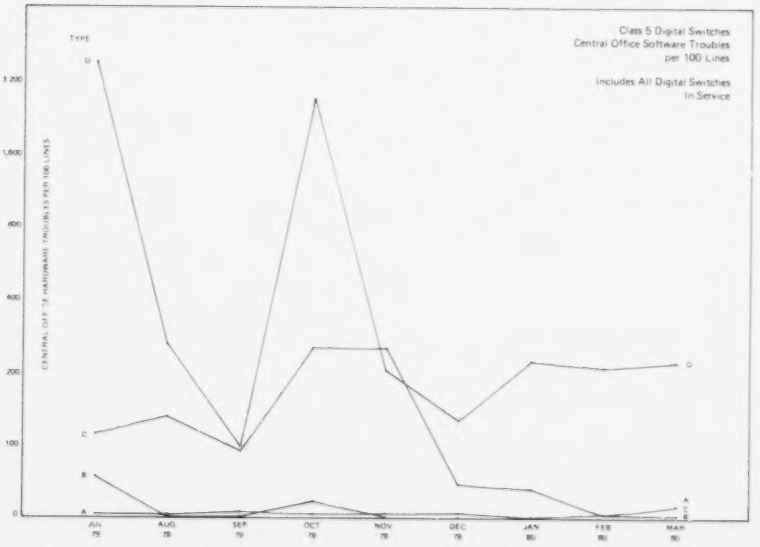

FIG. 6 *Class 5 switches, CO software troubles.*

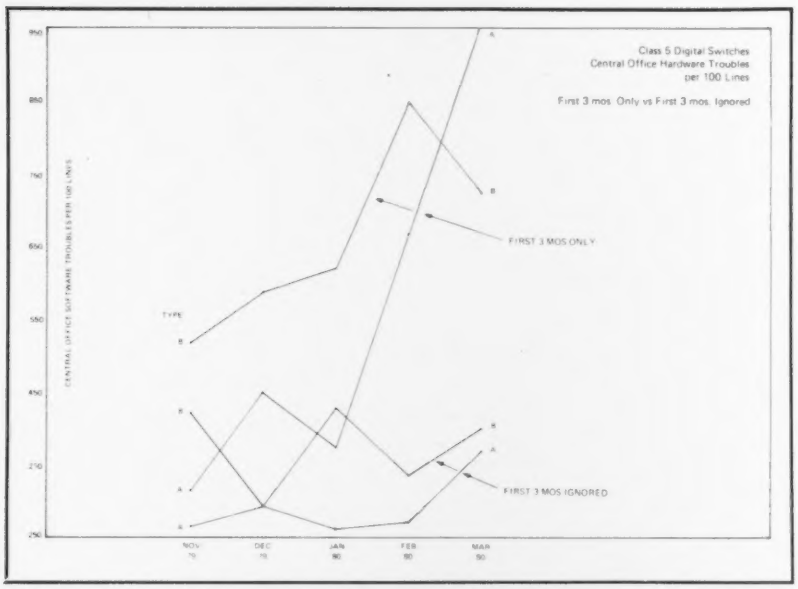

FIG. 7 *Class 5 switches, CO hardware troubles.*

tors. Although Stromberg-Carlson employs an analog concentrator in some configurations of its switch, it is not used in the Continental Telephone applications. The switching network for the ITS 5 uses STS, whereas all the others use TST. The ITS 5 is non-blocking in the non-concentrating portion of the switching network, and all the others have some blocking. The DMS 10, DMS 200 and DCO use per-line codecs, while the others use shared codecs. With regard to the other items in the list it can only be said that a given switch should have sufficient terminations, call-carrying capacity, processor capability, and memory to satisfy the intended application for the desired length of time.

A few other comments are appropriate. Bit switching is more compatible with incoming serial digital data signals but less compatible with incoming byte organized PCM lines. Analog concentrators will not be satisfactory in the long run when digital subscriber loops are employed. It is relatively inexpensive for the non-concentrating portions of TDM switching systems to be made non-blocking. For trunk switching this provides the following benefits:

- Rearrangements are not required;
- Nailed up connections will not cause blocking for other traffic;
- Multi-slot connections will not cause blocking for other traffic.

There is a digital switch design issue that has to do with integral versus external capabilities. Users naturally would like to have the switch do everything—loop plant

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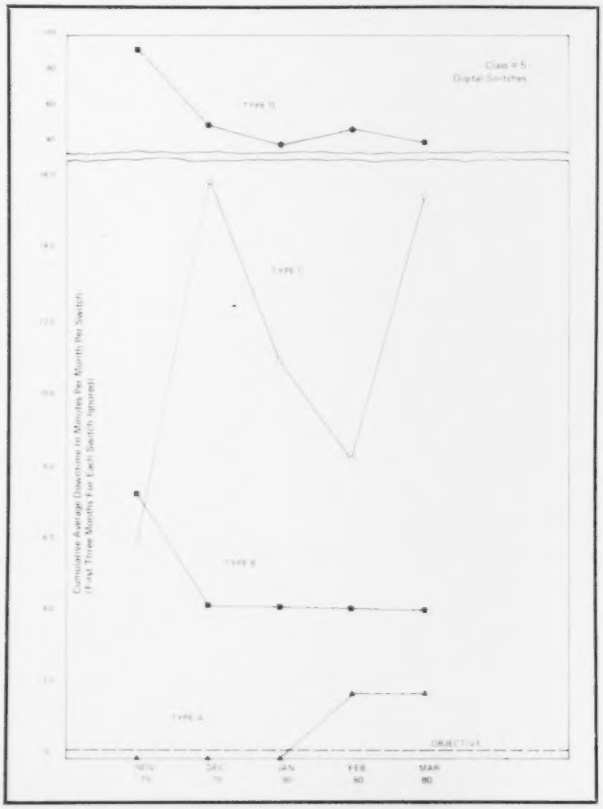

FIG. 8 *Class 5 digital switches, average downtime.*

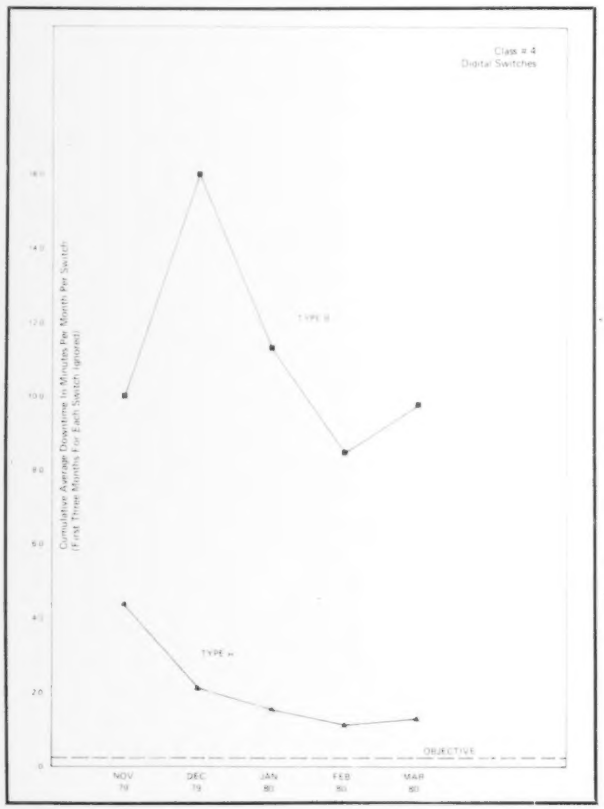

FIG. 9 *Class 4 digital switches, average downtime.*

monitoring and testing, trunk monitoring and testing, data collection, data processing and remote transmission. Manufacturers probably feel that they are being pressed to do too much too fast and that it may not be cost-effective to make all of these additional functions integral with the switch rather than external. Clearly, more processing power, more memory and more software are required, and there are costs associated with all these. More tradeoff studies are needed to ascertain the optimum division between integral and external functions. However, as time goes by it is probable that more integration will be cost-effective as a result of the rapidly inflating cost of labor incurred with separate, less automated systems.

Performance standards

Some measures of performance for a digital switch include the following:

- Error rate: $1x10^{9}$ or better at 64Kbps;
- Slips: 1 in 70 days or better at 64Kbps;
- Transmission delay;
- Jitter and wander;
- Grade of service: blocking probability, $1x10^{-3}$ or better, probability of delay;
- Switching delay: call set-up time;
- Probability of premature release of a connection;
- Probability of incorrect charging;
- Frequency of loss of framing;
- Circuit quality.

A great deal of work is being done by CCITT (International Consultative Committee on Telegraph & Telephone) study groups to specify requirements for each item on the above list. A few tentative proposed numbers are shown above to illustrate that firm numbers will be forthcoming for these and other performance criteria.

Tracking trouble

A series of graphs accompanying this article illustrate the experience thus far with digital switching troubles. Figure 3 represents the monthly comparison of four types of digital switches from July 1979 through March 1980. Central office troubles per 100 lines per month is represented with Continental's Eastern Region's overall average provided as a comparison. As shown in Figure 4, this overall average is dominated by the large percentage of step-by-step switches that remain. However, it can be seen that for one of the three Continental Telephone regions which is typical of the others almost 50% of the lines will be on digital switches by 1984. Two observations can be made with respect to Figure 3: first, there seems to be an overall settling down of troubles attributable to the digital switches; and second, after settling, the troubles attributable to all four types of digital switches are below the Eastern Region average, which indicates that digital switching has fewer maintenance problems.

The second and third graphs in this series provide a more in-depth analysis of the first graph. Figure 5 shows the amount of the central office troubles attributable to hardware problems, and Figure 6 indicates troubles related to software.

Both graphs indicate a recent lessening of troubles. It is obvious that major hardware problems are being overcome by the manufacturers, but that improvement still is needed. The existing software generics for one manufacturer's switch have maintained the objective of zero troubles per 100 lines per month over the last five months. The other types of switches continue to have some software problems.

Hardware and time

Figure 5 shows the decrease in total hardware problems as a function of time. In Figure 7 the hardware troubles are segregated into two categories: first, troubles encountered in the first three months of a switch's life; and second, troubles encountered during and after the fourth month. For simplicity, the data is graphed on only two types of switches. It can be seen from this graph that after a three-month period, the troubles per 100 lines per month decreased considerably for both types. It also is apparent that the number of hardware problems encountered in the first three months is considerably higher than an acceptable level and even after the first three months the switches still are encountering more hardware problems than the objective. The objectives that have been established

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are 0.2 trouble per 100 lines per month for hardware and zero troubles per 100 lines per month for software. None of the four manufacturers is meeting the first objective as yet, and only one manufacturer appears to be meeting the second at this point.

Availability

With respect to availability, the best measure is downtime in which the switch is completely out of service.

The long established objective for downtime is one hour in 20 years. This is equal to an average of three minutes per year, or an average of one-quarter of a minute per month. Negligible downtime probably is the most important factor contributing to customer satisfaction. Figure 8 shows the downtime experience accumulated to date for class 5 digital switches. In order to give each manufacturer a reasonable opportunity to shake down early problems, downtime for the first three months for each switch has been excluded. For each month the total downtime for the current population of each type of switch is divided by the population number to get the average downtime in minutes per month per switch for that category.

Monitoring

Then these monthly averages are used to get a cumulative average in which all the monthly averages up to the current month are added and the sum divided by the number of months accumulated since the November 1979 start. The objective is shown as a dotted line at a cumulative average of 0.25 minute per month per switch. A well-behaved switch will approach the objective in a reasonable amount of time in an exponential or damped oscillatory manner. It can be seen that the four types differ widely in their behavior. Only type A is within reasonable distance of the objective at the present time. Likewise, Figure 9 shows that the two types of class 4 digital switches show significantly different behavior patterns. Type A shows a very nice classical exponential approach to the objective.

There is no substitute for this type of continuous monitoring of performance to make sure that objectives are being met. □

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which are simultaneously.

Relating phase shift to envelope delay. Amplitude modulating a low frequency sine wave (f_m) onto a carrier frequency (f_c) produces an amplitude modulated (AM) signal as shown by waveforms (a), (b) and (c) in Figure 5. The envelope of the AM signal is the outline of the peak excursions of the modulated signal as shown in waveform (d) of Figure 5. The AM process produces a signal whose frequency spectrum consists of the carrier frequency plus an upper sideband ($f_c + f_m$) and a lower sideband ($f_c - f_m$). Figure 6 illustrates this relationship. Because the upper sideband is of a higher frequency than the carrier, it undergoes a greater phase shift than the carrier; because the lower sideband is of a lower frequency, it undergoes less phase shift.

If the AM signal is transmitted over a circuit, the phase shift difference between the lower and upper sidebands causes the modulation envelope to experience a phase shift (or a delay). With a constant f_m the frequency difference between the sidebands is constant regardless of f_c. If there is no phase distortion, that is, phase shift is linear with frequency, the delay for a constant f_m also will be constant as f_c is changed. (See Figure 7A and 7B.) With phase distortion the envelope delay-versus f_c curve will look more like Figure 7D.

The measurement technique is based on measuring envelope delay as f_c is varied across the line's bandwidth. As shown in Figure 8 one test instrument transmits an AM signal, the receive instrument saves the envelope information and uses it to amplitude modulate a fixed f_c back to the transmit instrument. Any delay introduced in the return loop will be constant and can be zeroed out. The transmit instrument then can compare the phase of the retransmitted f_m envelope with the originally transmitted f_m. Envelope delay is expressed in microseconds and usually is given as microseconds more delay than the delay at 1800 Hz.

Envelope delay can be controlled by phase equalizers. It is tariffed parameter for C level conditioning. Figure 9 illustrates the C2 limits on envelope delay.

In the CCITT environment, phase shift characteristics are measured by a slightly different technique referred to as group delay. □

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Rolling, rolling, rolling, keep those telcos rolling!

A Telephony study examines the parameters of the vehicle fleets of the U.S. telephone industry—all the data fit to print

THE AFFILIATES OF American Telephone & Telegraph Co. (AT&T), New York, N.Y., the parent company of the Bell System, operate the largest private vehicle fleet in the U.S., according to a recently released study conducted by the Market Research Dept. of Telephony Publishing Corp., Chicago, Ill.

The U.S. telephone industry as a whole, including the nearly 1500 Independent telephone companies, operates nearly 260,000 vehicles, according to the study.

The study, *Vehicles in the U.S. Telephone Industry: A Stable Growth Market*, was made by Research Manager Dana Inan of Telephony Publishing. It costs $35 per copy.

The companies covered in the study serve 96% of all U.S. telephones. Some of the study's highlights are discussed below.

Bell on wheels

The Bell System's vehicle fleet contains approximately 40,000 automobiles, about 106,000 light trucks and vans, and more than 47,000 trucks which weigh more than one ton. The Bell System fleet thus contains more than 193,000 vehicles, 80% of which are vans, light trucks or heavy trucks.

As of the end of 1978, the Bell System's vehicle fleet represented a capital investment in excess of $1 billion. The estimated annual cost of fuel and repairs for the vehicles came to another $400 million.

"With such a large fleet, even a small savings per vehicle can make a sizeable total savings," the study says. "The Bell System operating companies, as do the larger Independents, have a number of computerized systems for fleet tracking and management."

The Bell System owns 99% of its vehicle fleet. However, the amount of maintenance work done by Bell System mechanics varies widely. Companies which operate in centralized areas, such as Illinois Bell Telephone Co. or New York Telephone Co., do almost all of their maintenance work themselves. Companies which serve less densely populated areas, and consequently have garages which are widely separated, tend to have outside agencies do more of their maintenance work; companies like Southwestern Bell Telephone Co. or Mountain States Telephone & Telegraph Co. fit this description. There are other factors besides the type of service area, such as garage capacity, which also affect maintenance decisions.

Affiliates of General Telephone & Electronics Corp. (GTE), Stamford, Conn., operate a fleet with about 35,500 vehicles, not counting vehicles operated by affiliates based outside the U.S. GTE companies, like Bell System companies, tend to own their vehicles. At GTE companies, like Bell System companies, "the decision of whether to perform maintenance and vehicle repair in-house or through local garages and dealers, and the mix, has a lot to do with the availability of these supports and the nature of the operating company's own serving area characteristics," the study says.

The companies affiliated with Continental Telephone Corp., Atlanta, Ga., operate a fleet of 8000 vehicles. Only about 500 of those vehicles are owned by the operating telcos. About 1000 of the vehicles are leased from a Continental Tel leasing subsidiary, and the rest are leased from other sources.

The study also contains information on the vehicle fleets of the other Independent telephone holding companies. Affiliates of United Telecommunications, Inc., Kansas City, Mo., operate a fleet of more than 8900 vehicles; the affiliates of Central Telephone & Utilities Corp. (Centel), Chicago, Ill., operate about 3000 vehicles; the affiliates of Mid-Continent Telephone Corp., Hudson, Ohio, operate more than 1600 vehicles; and the remainder of the Independent telephone industry operates more than 12,300 vehicles.

The study contains another interesting statistic. *All* of the vehicles owned by U.S telephone companies were manufactured in the U.S. This contrasts sharply with the success non-U.S. manufacturers have had in other sectors of the U.S. automobile market; their vehicles currently account for 25% of the U.S. market.

Besides compiling quantitative data, the study also contains information on future trends; for instance, there is information on why some companies are turning to vehicles with fiber glass bodies while others are not.

For more information on *Vehicles in the U.S. Telephone Industry: A Stable Growth Market*, contact Telephony Publishing Corp., Market Research Dept., 55 E. Jackson Blvd., Chicago, Ill. 60604; telephone: (312) 922-2435; telex: 910-221-1058.

Or just drive your car, van, light or heavy truck on in. □

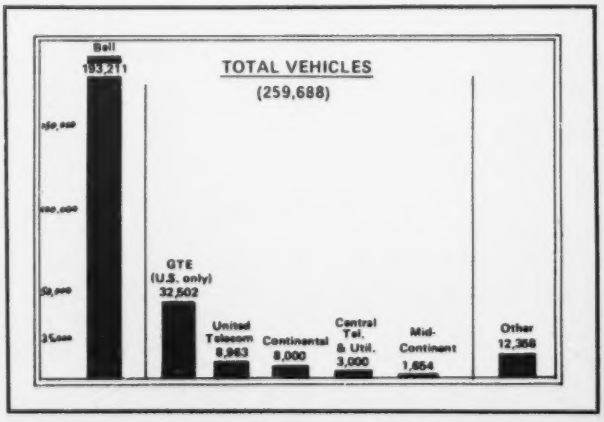

FIG. 1 *The Bell System dominates the other telcos when it comes to total number of vehicles.*